AUTOMATION

NOVEMBER 1956

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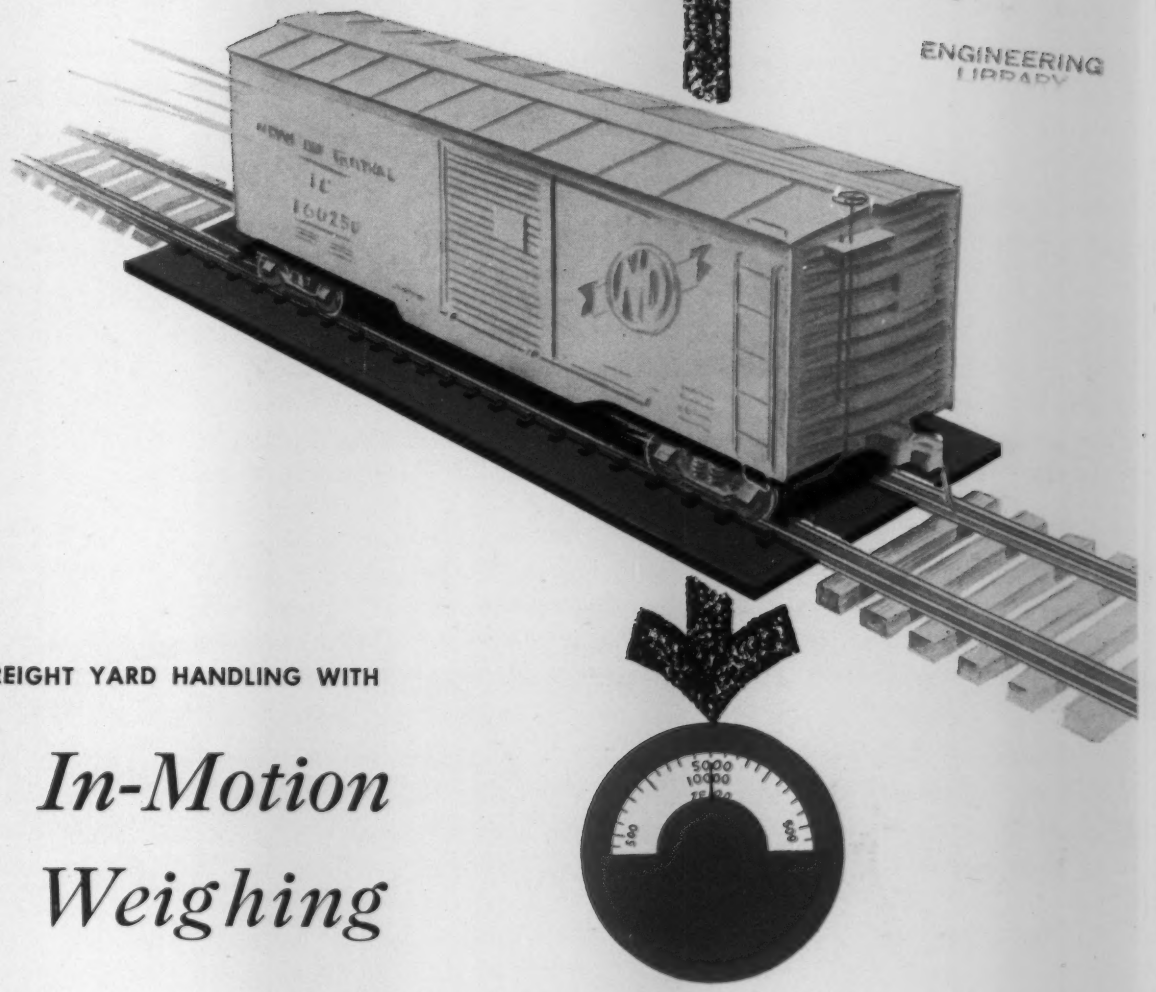


FREIGHT YARD HANDLING WITH

In-Motion Weighing

The Magazine of Automatic Operations

- Punched Card Controlled Batching
- Photoelectric Control in Log Handling
- Automated Assembly
- Applying Telephone Switches and Relays

CONTENTS—PAGE 3

A PENTON PUBLICATION

WEAN "AUTOMATED" TRANS-CAR LINE SOLVES HEAVY PARTS HANDLING PROBLEM

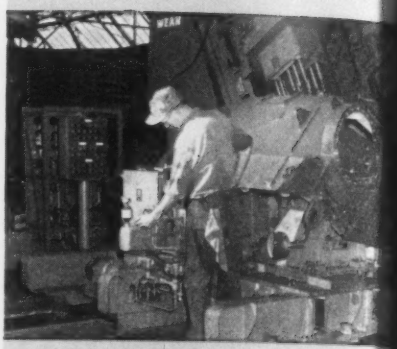
Unique system carries bulky sections through entire machining operation

The Massey-Harris Co. is used to handling and precision working large machine components. Thus, when they accepted the contract to produce combat vehicle hulls for the Army they immediately got in touch with Wean Equipment engineers.

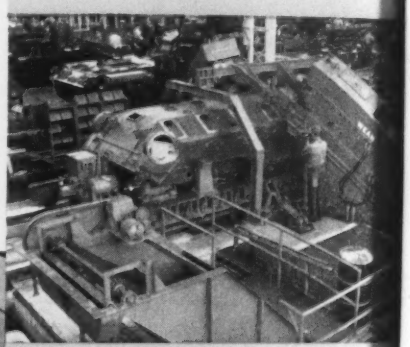
A team of Wean Equipment engineers working with a similar group from Massey-Harris soon vetoed the possibility of using standard machine tools on a cost basis. It was decided a complete line, especially built to do the job, was the only practical answer.

In eight months' time, Wean Equipment developed and built the now famous trans-car line. The line is composed of three stations: milling, drilling, and boring. The unusual feature is the car that operates on a set of tracks, running between stations, and eliminates all handling of the bulky, heavy hull.

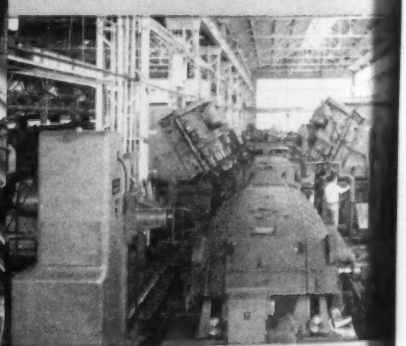
If special "automated" machinery is what you're looking for, call in a Wean Equipment man today. He represents probably the widest experience in specialized machinery to be found anywhere. Like Massey-Harris, you'll find Wean the surest, most inexpensive way to soundly engineered, result-getting machinery.



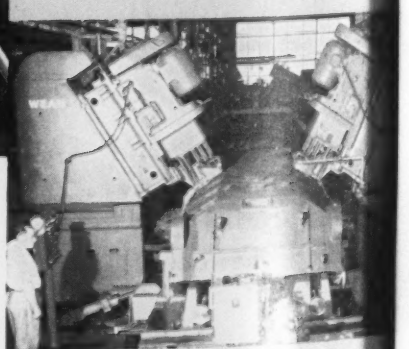
Unique trans-car that carries hull f station to station.



Milling operation. Dry cutting carbide cutters. Air jets remove ch



Drilling operation. Beneath the fl coolant system with magnetic separator.



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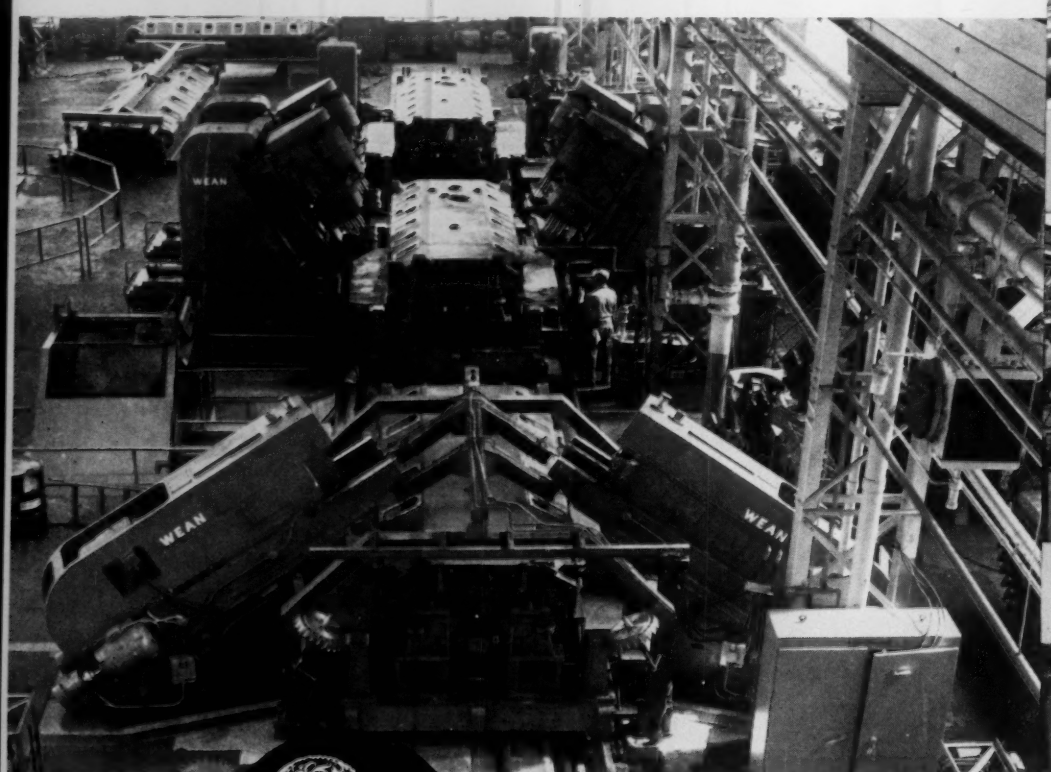

Over-all view of Wean Line that effected tremendous savings in producing giant hulls.

Wean

EQUIPMENT CORPORATION

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NOVEMBER 1956
Vol. 3—No. 11

AUTOMATION

A PENTON PUBLICATION

The Magazine of Automatic Operations

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REGULAR DEPARTMENTS

Automation Outlook, 4
Automation News, 9
Reader's Reply Card, 17
Meetings and Events, 25
Detroit Dateline, 33
Notes from Britain, 37
New Equipment, 87
New Components, 101
New Literature, 118
Abstracts, 123
Instrument Control of Power Plants
Materials Handling Trends
Patents, 129
Books, 131
Editorial Index, 132
Bibliography, 135

At the Crossroads, 43
EDITORIAL—changing functions of industrial and management engineering requires re-evaluation of activities.

In-Motion Weighing, 44
R. B. ZILIUS—automatic load cell system used to speed weighing of freight cars in classification yard.

Automated Spline Broaching, 48
AUTOMATION TODAY—handling of broaches and workpieces integrated into automatic machine cycle.

Applying Telephone Switches and Relays, 50
F. R. POPOLI—electromechanical devices, "work horses" of automation, in development for over 60 years.

Photoelectric Control in Log Handling, 58
M. H. MATER and W. L. ANTONSON—sawmill operation for low-quality salvage logs varying in shape and weight.

Standard Grinder Fits Automated Line, 62
HANDLING SYSTEM—fork truck positions hopper that feeds piston pins to gage-controlled disk grinder.

Automated Assembly—2, 63
KENNETH R. TREER—second part of the series discusses transfer, fasten, sense, eject, and control elements.

Applying Magnetic Amplifiers, 71
JAMES R. WALKER—part one—diagrams and descriptions of four examples of controlling positioning motors.

Aircraft Skin Miller, 73
W. C. KRAFT—application of suitable drive and control equipment converts machine to automatic operations.

Automation in Action, 78
PICTORIAL PRESENTATION—welding, packaging, bonding, chemical analysis, dust collecting, and data processing.

Flow-Ratio Control, 80
INSTRUMENT SYSTEM—provides continuous fluid mixing by metering smaller quantity into a larger stream.

Punched Card Controlled Batching, 81
MATERIALS HANDLING — concrete ingredients are selected, weighed, and mixed in automated installation.

automation outlook

HORIZONTAL NATURE OF AUTOMATION

". . . not only does automation have a long history in telephony—dating back more than 60 years—but the industry is by far the most extensive user of relays, stepping switches, and other electromechanical switching devices that are the "work horses" of all electrical automation systems . . . considering the horizontal nature of automation, persons faced with control problems in other industries may find that some of these devices are of value in the solution of their own problems in automatic control . . ."—*F. R. Popoli, relay design engineer, Stromberg Carlson Co.,* *see page 50.*

INCREASING APPLICATION

". . . it seems to me that there are three things that are as certain as anything can be in our economic and social future: First, that which we call by the loose term 'automation' is going to find increasing application in the productive and distributive functions of our economy; second, that this automation will not cause widespread unemployment, but threatens instead to create a severe scarcity of certain kinds of labor, and although it will result in a decreased demand for unskilled labor, at the same time it will more than offset this by a greatly increased demand for skills of many kinds; third, that we are going to have to move quickly to do something about the severe shortage of engineers and scientists that is already upon us if the free world is to maintain its strength. The significant thing to remember about automation is not that it saves time, or that it cuts the labor force, but that it makes possible certain operations that would be impossible otherwise . . ."—*Joseph W. Barker, president, American Society of Mechanical Engineers.*

GREATER INTEREST IN AUTOMATION

". . . in summary form, we found that on the whole, the Russian plants we saw are not as productive as those in this country. They are not as well organized, not as clean and not as well lighted. Most material handling systems are obsolete. Much of the machinery is old, but most of it is in good condition and is being used to good advantage. However, we found that many of the adverse conditions we saw are in the process of being changed very rapidly. New automatic production machines are being designed and built, and the engineering on some of these lines would be a credit to any engineering group anywhere. Over all, the interest in automation appeared to be greater in Russia than it is in the United States . . ."—*Nevin Bean, technical assistant to the general manager, Automatic Transmission Div., Ford Motor Co.*

VOICED: A NOTE OF CONFIDENCE

". . . a note of caution is sounded concerning blind acceptance of any one of these schemes as the complete solution for present automatic production. But, at the same time, a note of confidence is voiced that out of these concepts of automation and semi-automatic production will soon come a philosophy which will successfully marry automation techniques to the reliability requirements of even the intercontinental guided missile . . ."—*Alfred R. Gray, electronic design specialist, Glenn L. Martin Co.*

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Published by

THE PENTON PUBLISHING COMPANY

G. O. HAYS ..... *President*
R. C. JAENKE ..... *Executive Vice President*
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Subscriptions in United States, possessions, and Canada for home-addressed copies and those not qualified under above rules: One year $10. Single copies $1.00. Other countries: One year $20.

Published monthly and copyrighted 1956 by Penton Publishing Co., Penton Bldg., Cleveland 13, Ohio. Accepted as Controlled Circulation Publication at Cleveland, Ohio.

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AUTOMATION news

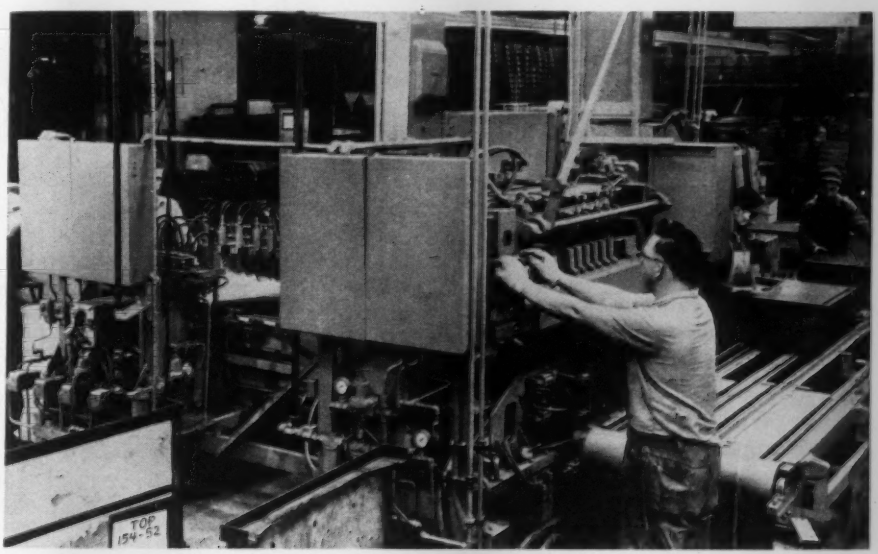
Today's events and developments in the field of automation

New Rolling Mill To Receive Programmed Control System

NEW REVERSING ROUGHING mill now being completed for Jones & Laughlin Steel Corp.'s Aliquippa Works is expected to be the steel industry's first completely automatic card-programmed rolling mill. Its control system, developed by Westinghouse Electric Corp.'s Motor & Control Div., will permit an operator to initiate a detailed rolling schedule by simply pressing a pushbutton. By selecting the proper card from several prepunched for each schedule, it will be possible to attain a definite set of reductions while allowing for variations in temperature and composition among individual slabs.

When in operation in late 1956, the card programming control system will be given the schedule for any set of rolling operations in the form of prepunched IBM cards. These cards can be prepared for practically every slab and strip size and grade of steel so that proper drafts and speeds will produce a product of high uniformity at a high production rate. Each card will include all the requirements of a given schedule: Mill screw-down opening, edger adjustment, mill speed, and edger speed. Also included will be a notation to indicate when the last pass has been completed.

After a stack of punched cards is placed in the IBM card reader, the card applying to the first schedule is read and all information is transferred to a transistorized memory storage element. The mill is then to roll the entering slab. Automatic operation takes place when the first pass is initiated by the operator's pressing the pass-advance pushbutton.



SPECIAL PURPOSE automatic welding machine installed at Toledo Desk & Fixture Co. plant can turn out 400 kitchen cabinets in 1 hour. It is operated by four men. The user company worked closely with Resistance Welding Corp., Bay City, Mich., builder of the electronically controlled machine, to achieve a satisfactory design. Unit is adaptable to different size cabinets. As a comparison to present production rates, formerly 18 men took 1 hour to make 140 cabinets.

As the slab approaches, the control equipment acts through magnetic amplifier output units to preset roll openings and speeds. After one pass, reversing is brought about by sensing devices that read the position of the slab and reverse the rolls after a brief period of slow-down. After all but the final pass, roll openings and mill speeds are readjusted in accordance with the schedule filed in the memory storage element. When the final pass is completed, an indicator light automatically signals the operator at the crop shear that the strip is ready to enter the finishing mill.

The mill will then be preset for the next schedule by pressing the schedule advance pushbutton. Again, a punched card is read by the card reader, its information is transferred to the memory storage element, and the mill is made ready for the schedule required for the next slab.

Economics of Data Processing Tied to Annual Gross Sales

FORECAST OF A $2 billion market for large-scale electronic data processing systems has been made by **John E. Johnson,** sales director for Datamatic Corp. Johnson, basing his prediction on studies made by his company, has said of data processing systems that there are today "at least one thousand customers who are losing money every day they struggle along without one." He contends that each of these companies has the kind of sales volume and complexity of record keeping that

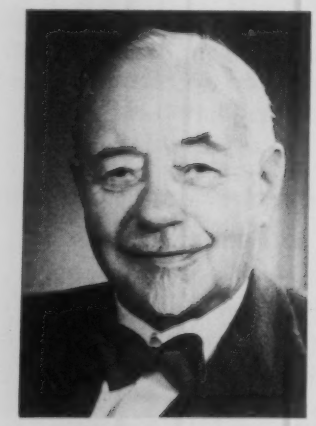
justify the purchase of an electronic data processing system. This would add up to a $2 billion market for the 15 major producers now making electronic data processing equipment.

So far as manufacturing companies are concerned, Johnson believes that electronic equipment becomes a good buy when annual gross sales are 100 times the "annual cost" of the system. Thus, he explains, a $36 million a year company could use a data processing system fitted with units costing an initial $2 million.

SPECIAL EDITION of the New York Times has been sent from New York to San Francisco by facsimile at the rate of two minutes per page. The edition was set in type and made up into pages in New York. Proofs of pages were scanned at the rate of over 200 square inches a minute at 200 lines per inch by a new facsimile transmitter. The impulses were transmitted over a microwave relay system and, in San Francisco, converted into light by a newly developed Sylvania gas-filled crater lamp. The light pulses were recorded photographically and photoengravings were made from the negatives. The new Times Facsimile Corp. transmitter turns at 1500 rpm and is capable of four times greater fidelity than older machines.

Automation Introduces Feature Contributed By British Expert

DEDICATED to the task of presenting the automation story, AUTOMATION magazine feels that it is important to follow foreign developments in this modern technology. Within the European area, Britain appears to be one country which has developed a concept of automation most closely resembling the evolving American idea of the subject. It is apropos then, that with this issue, AUTOMATION introduces to its readers a feature column prepared by an outstanding British engineer, **Frank G. Woollard.** He is the author of



"Principles of Mass and Flow Production," the only British textbook dealing with automation in the metalworking industry.

The conception of a column, to be prepared in Britain by a source with the background, reputation and contacts which would insure for AUTOMATION's readers the most informative reading, was the outgrowth of the realization that interchange of information between Britain and America would be of considerable benefit to both countries. Naturally, no modern nation is completely devoid of an indigenous historical base suitable for the development of automation, but a number of factors have resulted in some being better prepared than others. And, as might be expected, this is evidenced by the extent to which automation has caught on in these countries since present-day developments are based on yesterday's preparation.

In this respect, the subject matter chosen by the author of AUTOMATION's newest feature section, entitled "Notes from Britain" is most pertinent (See page 37). In this first column, Mr. Woollard introduces the readers to the inception of the transfer machine—an auspicious beginning topic considering the interest in transfer machines within our country. It is also auspicious from an editorial standpoint since it emphasizes the close association of our new correspondent to the fundamentals of automation.

Mr. Woollard began his distinguished career in industry as an apprentice to the chief mechanical engineer of what is now the Southern Railway in England. After short periods with various London concerns, in 1910 he joined E. G. Wrigley & Co. Ltd., Smethwick, as chief draftsman, later becoming director and chief engineer and eventually assistant managing director. During this period he was instrumental in developing flow production techniques for automobile components.

In 1923 he joined the Engines Branch of Morris Motors Ltd. as general manager, later being appointed a director of the parent company. It was at the Engines Branch that he took the lead in developing flow production to an advanced degree. The methods were described in an early paper entitled "Some British Methods of

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New *Synduction* Motor

...has uses in:

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- Wire Drawing
- Plate-Glass Conveyors
- Packaging Machinery
- Food Processing
- High Speed Cameras
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- Electronic Computers
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- Frequency Converter Sets
- Drives for Electronic Power Supplies
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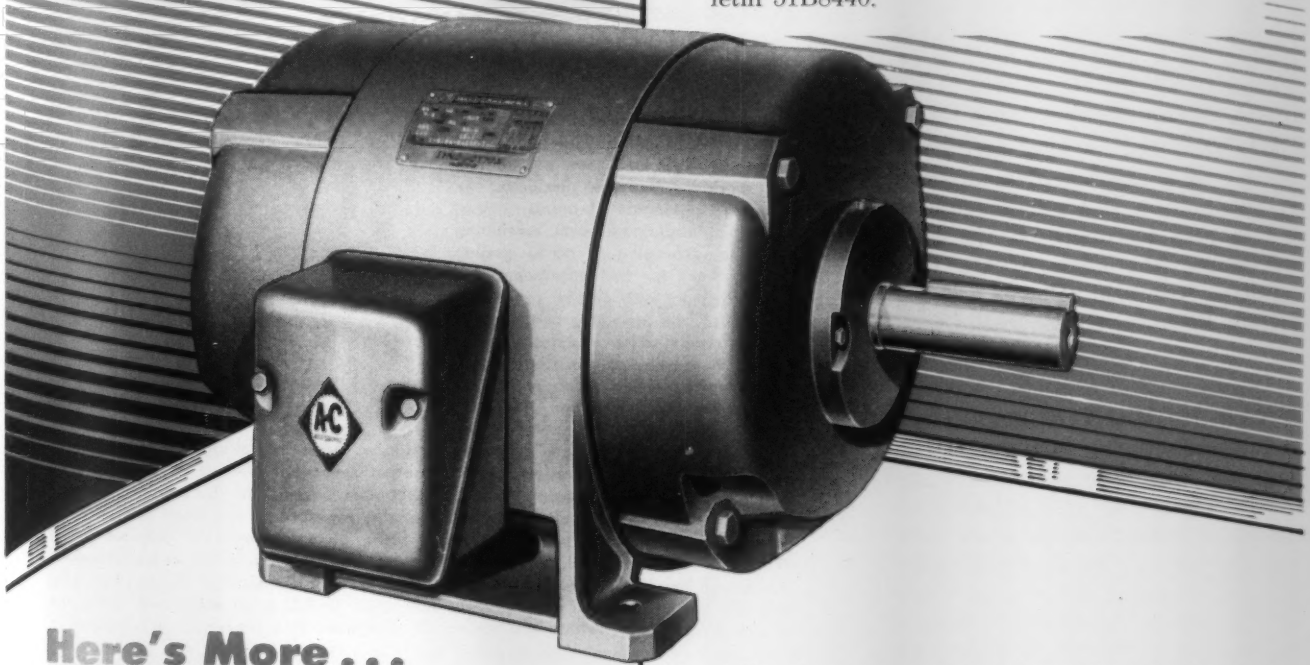
Allis-Chalmers engineers are anxious to help you determine where *Synduction* motors can improve your operations. Call your A-C office or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin, for Bulletin 51B8440.



Here's More...

- **Constant speed, regardless of load or voltage, depends only on frequency**
- **Synchronized speeds for a number of motors**
- **Adjustable speed by frequency control at any speed setting**

Allis-Chalmers new development—the *Synduction* motor — now makes these characteristics available at low cost. The sturdy frame and simple design, similar to that of a squirrel-cage motor, eliminates collector rings, brushes and rotor insulation — cuts maintenance. Other important advantages include across-the-line starting, wide range of speeds and high efficiency.

Synduction is an Allis-Chalmers trademark.

ALLIS-CHALMERS

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Continuous Production," delivered to the Institution of Automobile Engineers in February 1925.

In 1932 he joined Rudge-Whitworth Ltd., and was a principal in the reorganization of that company. In 1936 he accepted an appointment as director of Birmingham Aluminum Castings Co. Ltd. and the Midland Motor Cylinder Co. Ltd. from which he retired in 1953.

In addition he was president of the Institution of Automobile Engineers at the time of its amalgamation, in 1947, to the Institution of Mechanical Engineers and became the first chairman of the Automobile Division of that body. He was also chairman of the Executive Committee of the Aluminum Development Association for three years, and was recently retired from a four-year tenure as chairman of the Council of the Zinc Alloy Die Casters Association.

Mr. Woollard is now acting as advisor to a number of companies on automation and allied subjects and is also lecturing on the subject under the aegis of the universities, technical colleges and the British Productivity Council.

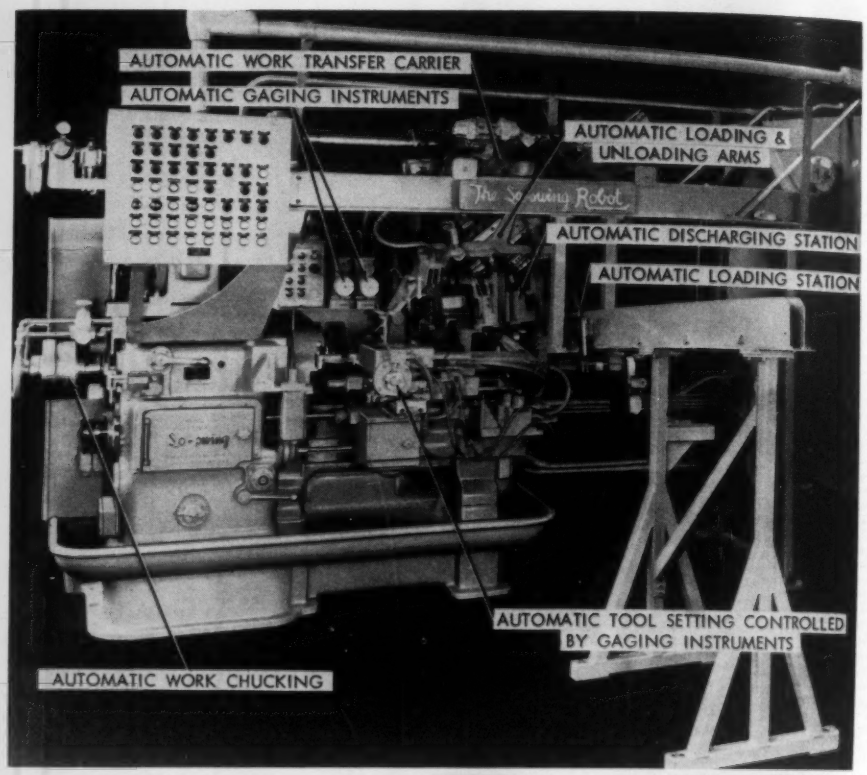
ESTABLISHMENT of engineering and manufacturing facilities in Los Angeles has been announced by Clark Controller Co., manufacturers of industrial electrical control equipment. **K. D. Christopher** has been named general manager of the newly established division. He has been with Clark Controller for 20 years, serving in the company's home office and Philadelphia office prior to establishing the Los Angeles sales office in 1951.

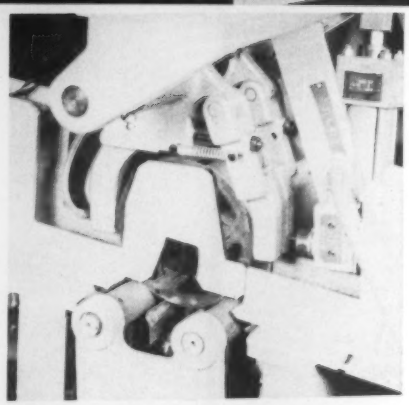
Germans Test Mail Sorting Plan

AUTOMATION OF MAIL distribution is the current goal of the German Post Office. With 70 per cent of the mail originating in German commercial establishments, the Post Office, which also controls the telephone system, expects to be successful in introducing a four-number code which will correspond with telephone office call numbers. These are allocated on a national basis as a result of the introduction of an inter-city dial system. For a beginning, electronic sorting will be adapted to a pilot installation already in use.

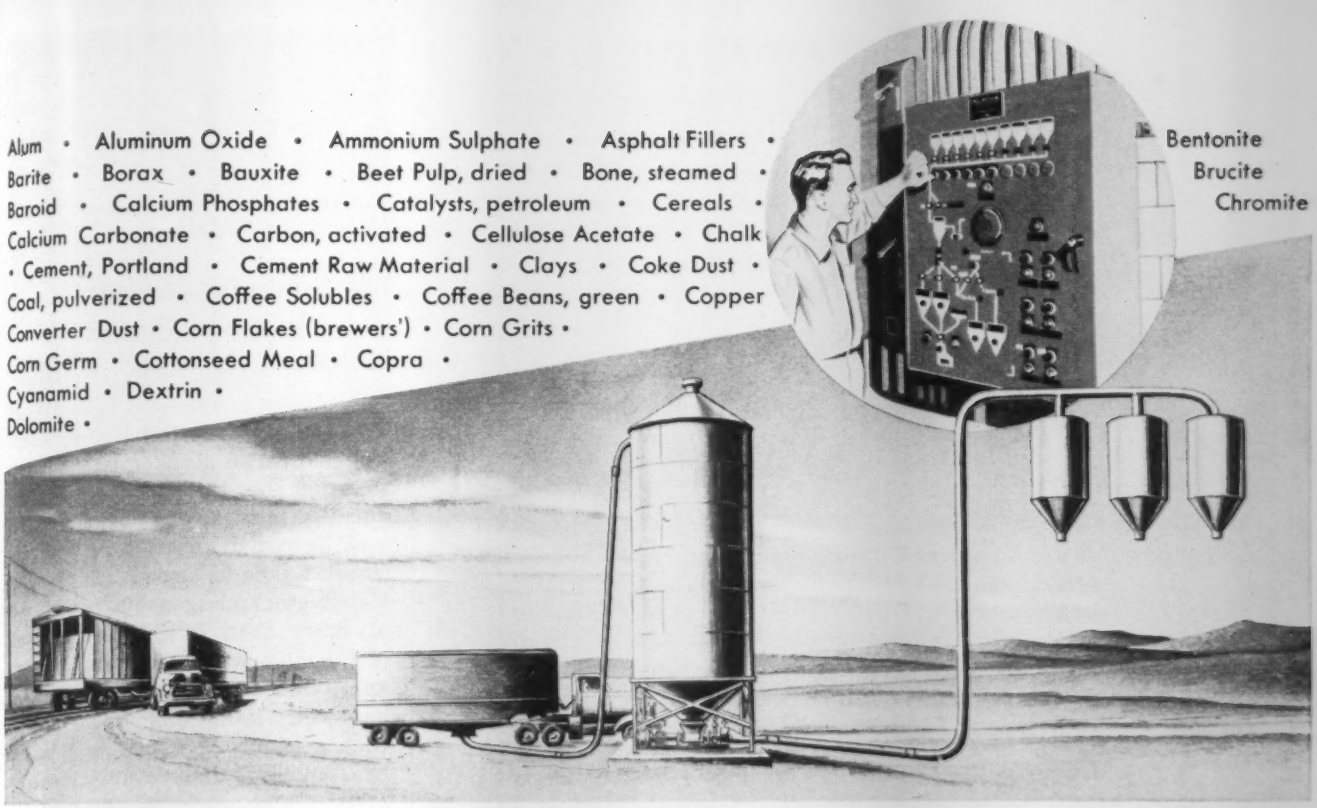
ACQUISITION of the A. Kimball Co. and the K. J. Braun Engineering Co. Inc. by United Shoe Machinery Corp. has been announced. The Kimball Co. recently introduced equipment which facilitates mechanical processing of information contained on price and inventory tags onto punched cards through use of existing office type business machines. The Braun Co. originally designed and manufactured the equipment for this system for the Kimball Co.

United has stated that both companies will continue to operate as they have in the past under existing management. It is ex-


AUTOMATIC WORK TRANSFER CARRIER
AUTOMATIC GAGING INSTRUMENTS
AUTOMATIC LOADING & UNLOADING ARMS
AUTOMATIC DISCHARGING STATION
AUTOMATIC LOADING STATION
AUTOMATIC TOOL SETTING CONTROLLED BY GAGING INSTRUMENTS
AUTOMATIC WORK CHUCKING



SATISFYING requirements for one of their customers, Seneca Falls Machine Co., Seneca Falls, N. Y., has developed a completely automated lathe for machining the OD of small electric motor stators. As illustrated, one of the several machines supplied includes the following automatic features: Input conveying, loading of parts, machining operation, unloading of parts, gaging with feedback for tool adjustment and tool indexing, and output conveying. The stators are fed by gravity into a pivoting cradle which elevates a rough stator into the loader arm fingers of a work transfer carrier which moves the part to the loading station. The part is positioned on an expanding arbor where it is securely clamped by an air cylinder. After the machining operation is completed, the part is transferred to the output conveyor where it is fed by gravity to the gaging station. Gaging is by the Lectrolair system and the stator is checked for size on both ends simultaneously. If the part registers on the mean tolerance, no adjustment signal takes place. However, if the diameter tends to increase but is still within tolerance, a signal is stored in a memory device. After a predetermined number of consecutive parts indicate a trend, a signal is sent to the control panel and the turning tool is automatically advanced 0.0005-inch which will bring the turned diameter just within the low limit tolerance. This procedure is repeated a predetermined number of times after which the turret tool post will automatically index to present another of the four tools held in the four-tool turret. After the four tools have been used, the machine will stop and a light will signal that a turret tool change is required.



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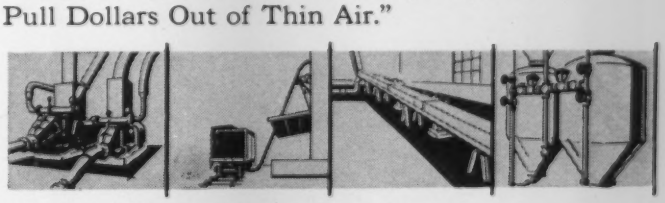

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AIRengineering at work
REPORT No. 5098B-3

Multiple Screw Driver assembles 400 carburetors per hour

Assembling carburetors was a slow, one-screw-at-a-time operation until AIR engineering solved the bottleneck. Now one operator uses this 8-spindle automatic Multiple Screw Driver to help turn out more than 6 completed carburetors per minute—400 every hour.

This compact, easy-to-operate Multiple Screw Driver is just one more example of how AIR engineering is helping modern industry solve problems and cut production time and costs.

All the experience of Ingersoll-Rand in speeding up fastening through AIR engineering multiple units is yours for the asking. Whether your operations involve screw-driving or nut running with either hand-held or automatic production line units, Ingersoll-Rand can engineer and build just the unit best suited to your needs.

8-Spindle Multiple Screw Driver for carburetor assembly.

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pected that United's research and manufacturing facilities as well as its experience in leasing and servicing machinery will complement the activities of the two newly acquired companies.

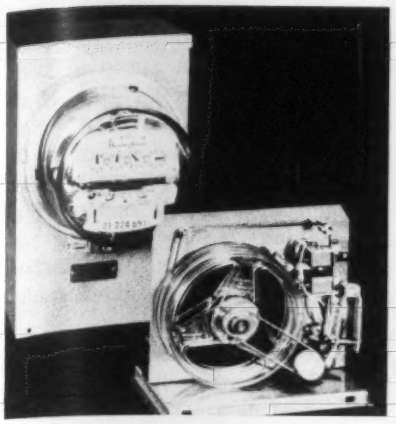
Low Grade Ore Mining Aided By Large Stacker

HUGE SELF-PROPELLED stacker is now in the process of erection for Erie Mining Co. by Link-Belt Co. The stacker will be used to stockpile taconite pellets produced during the five winter months when navigation on the Great Lakes is closed. It is capable of stockpiling a 90-ft high pile of more than 4 million net tons of taconite pellets covering an area approximately 800 ft wide at the base and 1300 ft long. The stacker with a radius of 275 ft will be fed by a trailing belt conveyor about 1400 ft long which moves with the stacker. When navigation on the Great Lakes resumes in the spring, the taconite pellets will be reclaimed for shipment to lower lake steel mills.

DURING THE ELEVENTH Annual Instrument-Automation Conference in New York City, **Justus T. Vollbrecht,** president of Energy Control Corp. was elected national president of the Instrument Society of America. He succeeds **Robert T. Sheen,** president of the Milton Roy Co.

The new ISA president founded the Energy Control Corp. He received an electrical engineering degree from the University of Cincinnati, took post graduate work in business administration at Northwestern University, and was previously national treasurer of the Society.

ORGANIZATION of Ouellette Associates Inc., a firm that will develop and manufacture special automatic equipment has been announced by **G. P. Ouellette**, formerly vice president and member of the board of directors of Wrap-King Corp. Manufacturer of wrapping machines, Wrap-King Corp., was founded by Ouellette in 1947 and



COMPACT magnetic tape recorder installed at a customer's service connection is used by Westinghouse Electric Corp. as a means of gathering data for electrical power load surveys. The recorder transcribes load and time quantities as impulses on standard 600-ft lengths of dual track magnetic tape which permit a 32-day survey run without attention to the device. After the survey period, the tape is brought to a central location for playback to a translator unit which totals and converts time and load impulses to demand values. For permanent records these values are transferred directly to punched cards which have been prepunched with other pertinent survey information.

has subsequently become a subsidiary of Crompton Knowles Corp., manufacturer of fancy looms.

Ouellette Associates will concentrate on the development and prototype manufacture of self-designed equipment, will handle development problems of other firms, and will continue to develop equipment for Wrap-King Corp. and build their pilot models.

Tooling Service Established By Transfer Machine Producer

MANUFACTURERS OF ROTARY and in-line transfer machines, Ferguson Machine & Tool Co. of St. Louis, has announced a change in the firm name to Ferguson Machine Corp. At the same time, an announcement was made of the acquisition of additional facilities in Lebanon, Ind. The new plant, to be known as the Hicks Development Div., will be devoted to the design and building of automatic tooling for use with the company's basic transfer units. As with the high speed, precision indexing mechanisms and assembly machine bases produced by Ferguson, standardization in tooling will be empha-

New I-R Torque Control Impactools prove value on auto assembly line

A leading auto manufacturer reports greatly improved *product quality* on 3 auto and truck assembly line operations where Ingersoll-Rand Torsion Bar Torque Control Impactools have been used for 6 months.

A safety hazard is eliminated on one operation, where these new Impactools have made torque control possible for the first time. The photo above shows the I-R Size 5040T Torque Control Impactool securing the steering gear assembly to the truck frame.

Other major benefits include time saving, because these Impactools operate at full power and speed until they automatically shut off when pre-set torque is reached . . . and elimination of the need for hand torqueing on many nut running jobs.

Size 5040T 2 Torsion bars available with max. torques of 60 and 90 ft. lbs.

Write for the complete story on this latest I-R development!

Ingersoll-Rand

11 Broadway, New York 4, N.Y.

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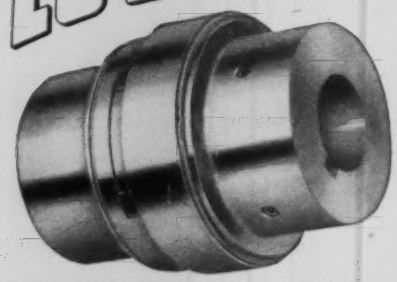
Circle 562 on Inquiry Card

15 YEARS SERVICE WITH ONE SET OF CUSHIONS

... actual report on

LOVEJOY



Flexible Couplings

Up to fifteen years maintenance-free service is not unusual with Lovejoy lubrication-free flexible couplings.

Performance like this is practical proof of these soundly engineered features:

SIMPLE, RUGGED CONSTRUCTION
Fewer parts. No intricate mechanisms. Nothing to lubricate.

LOAD TRANSMITTED BY CUSHION COMPRESSION
No wear on the metal jaws.

DOUBLE-LIFE CUSHIONS
One half of the cushions act as idlers—except on reversible loads. A quick interchange provides a new set of cushions. This can be done without dismantling the coupling.

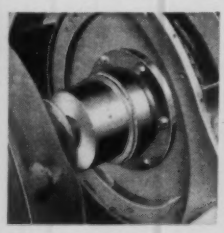


Illustration at right shows a Lovejoy Type CF flange-mounted coupling. Rated at 160 hp., 800 rpm., this space saver connects drive shaft between diesel power unit and generator.

You can get Lovejoy performance for your application.

Let us know your requirements or request complete-line catalog.

LOVEJOY FLEXIBLE COUPLING CO.

4951 W. LAKE STREET • CHICAGO 44, ILLINOIS

Mfrs. of Flexible Couplings, Variable Speed Pulleys and Transmissions, Motor Bases and Universal Joints.

Circle 563 on Inquiry Card

sized. Standard placing units and work stations, suitable for many special purposes, are now being developed. Standard items will be used wherever possible in building automatic equipment for orienting and placing parts, resistance welding, drilling, tapping, staking, machining, testing, inspecting and other operations performed on their machines.

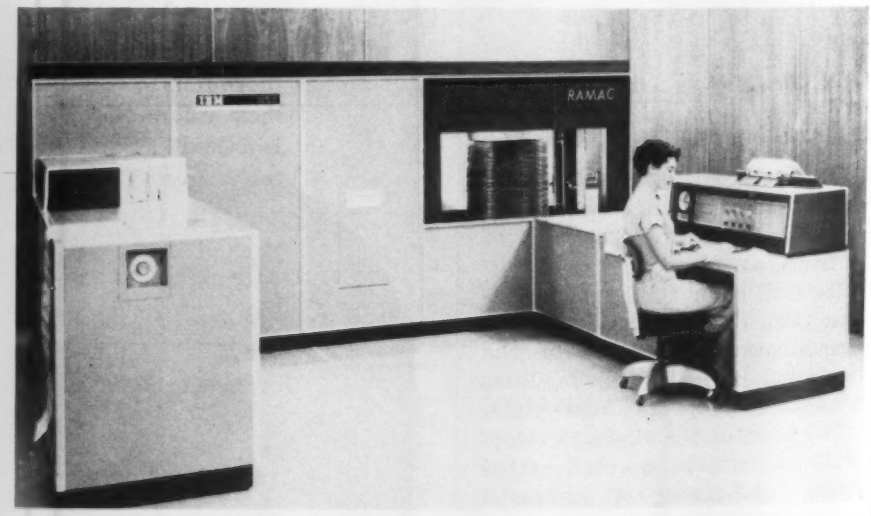
Personnel changes for the corporation have also been announced. **E. Gordon Reader,** formerly manager of the company's Roller Gear Div., has been appointed Vice President & General Manager of the corporation. **Stephen K. Georgieff** is Engineering & Sales Manager of the Roller Gear Div. while **James F. Miller** of Dayton, O., will manage the new tooling design service.

Random Access To Memory Unit Permits In-Line Data Processing

SEVERAL SIGNIFICANT data processing products have been introduced by the IBM Corp. The company has completed development of a magnetic disk memory device which is particularly useful in high-volume, in-line processing of business data. This memory unit consists of 50 magnetic metal disks arranged in a vertical stack similar to the appearance of records as stacked in some juke boxes. Both sides of each disk are used for recording of data. The entire stack rotates at a speed of 12000 rpm, enabling the location of addresses in the memory in a matter of milliseconds. Access to the individual recording tracks located on each disk is by means of an arm which moves vertically opposite a particular disk surface, and horizontally to a given storage track on the disk.

Several models of magnetic memory devices have been developed to date. One, with a storage capacity of 5 million digits, is part of a completely new system designated as the 305 RAMAC. Principal components of this system, in addition to the magnetic disk storage unit, consist of a printer used for the automatic preparation of reports; card punch which provides for an additional output device capable of punching 100 cards a minute; a processing unit which contains a magnetic drum for working storage and programing, various control circuits for data handling and arithmetic, etc.; and a control console which includes provisions for a punched card reader input and keyboard enabling the operator to query the memory disk in a random manner.

Typical uses of the 305 RAMAC include billing, inventory, sales analysis and updating accounts receivable; payroll and labor distri-



NEW data processing system has been announced by IBM. The 305 RAMAC is a complete system built around a new disk memory unit, having a storage capacity of 5 million digits. The random access memory unit consists of 50 magnetic metal disks arranged in a vertical stack. Operator access to the information on a disk is a matter of milliseconds. Remainder of system includes punched card input, arithmetical and logical processing equipment, and both punched card and printed output.

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starts on page 87

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405	435	465	495	525	555	585	615	645
406	436	466	496	526	556	586	616	646
407	437	467	497	527	557	587	617	647
408	438	468	498	528	558	588	618	648
409	439	469	499	529	559	589	619	649
410	440	470	500	530	560	590	620	650
411	441	471	501	531	561	591	621	651
412	442	472	502	532	562	592	622	652
413	443	473	503	533	563	593	623	653
414	444	474	504	534	564	594	624	654
415	445	475	505	535	565	595	625	655
416	446	476	506	536	566	596	626	656
417	447	477	507	537	567	597	627	657
418	448	478	508	538	568	598	628	658
419	449	479	509	539	569	599	629	659
420	450	480	510	540	570	600	630	660
421	451	481	511	541	571	601	631	661
422	452	482	512	542	572	602	632	662
423	453	483	513	543	573	603	633	663
424	454	484	514	544	574	604	634	664
425	455	485	515	545	575	605	635	665
426	456	486	516	546	576	606	636	666
427	457	487	517	547	577	607	637	667
428	458	488	518	548	578	608	638	668
429	459	489	519	549	579	609	639	669
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Information Service

For your convenience, advertisements and items of information on new equipment, components and manufacturers literature now can be quickly identified by an *Item Number* printed just below each unit.

For additional free information circle item number on an inquiry card. Fill in your name, title, address, etc.—Drop it in the mail—No Postage Required—Your request will receive prompt attention and will be filled directly by the manufacturer.

So that you won't have to clip this issue, we will gladly send you a personal copy of any article. Just fill in the page number and title of the article you desire.

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Keep Up-to-Date!

GOLD-N-RING ... a new name and a new conception of CONTROL SWITCH design

HEAVY-DUTY

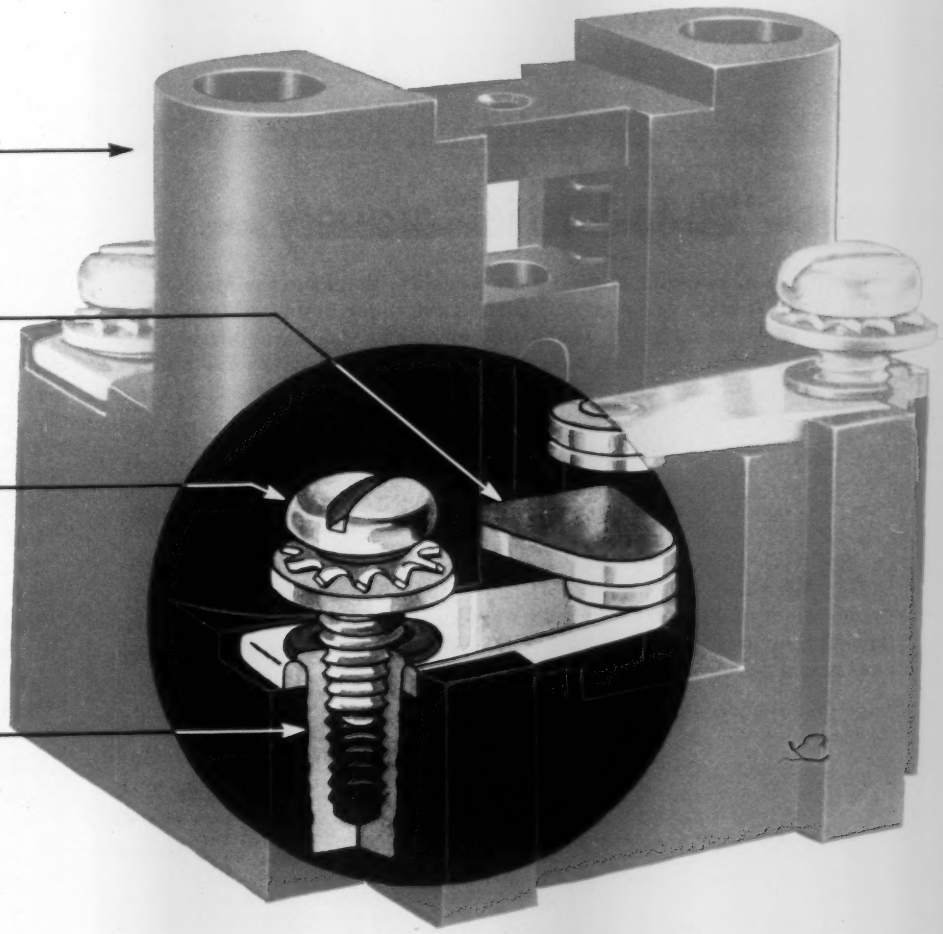
OIL-TIGHT—WATER-TIGHT—DUST-TIGHT

made by machine tool builders to machine tool specifications

A new name—GOLD-N-RING Sealtight Control Switch! A new conception—a control switch *designed and built BY a manufacturer of machine tools—FOR machine tool builders!*

A product of the same machine tool background responsible for Namco Solenoids and Snap-Lock Limit Switches, it gives designers a *package of greater electrical efficiency*—available from a single source, with a single source responsibility.

Shown here are only a few of many reasons why the GOLD-N-RING Control Switch makes it possible to match machine tool mechanical ruggedness with equally durable electrical efficiency.



1. **MAIN BLOCK** is unit-molded to assure alignment and simplify assembly.

2. **HEAVY-DUTY SILVER-ALLOY CONTACT POINTS** for maximum electrical capacity and long life.

3. **HEAVY-DUTY TERMINAL SCREWS**, with 3/8" thread contact, prevent stripping during installation; permanently secure wires for continuous trouble-free service.

4. **BRASS INSERTS MOLDED IN THE BLOCK** permanently hold stationary contacts. They also provide more thread support for the No. 8-32 terminal screws that are equipped with captive flat and lock type washers.

For complete details, send for Bulletin ECS-56. Better yet, ask for a representative to bring a switch for your examination.

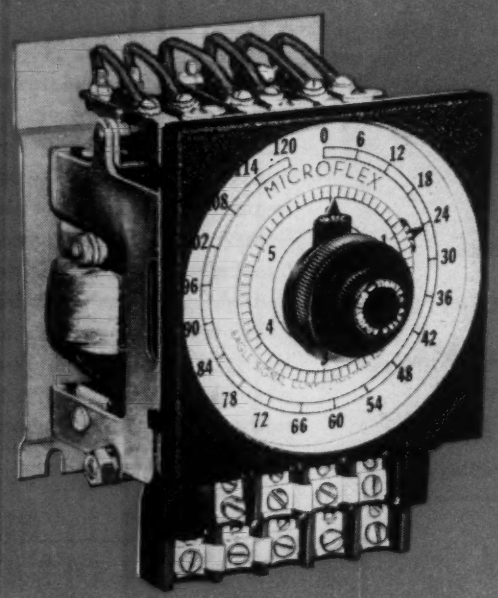
ELECTRICAL MANUFACTURING DIVISION

National Acme

THE NATIONAL ACME COMPANY • 196 EAST 131ST STREET • CLEVELAND 8, OHIO

Circle 564 on Inquiry Card

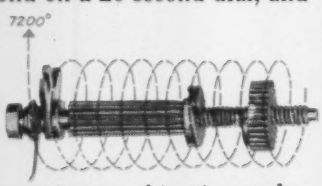
EAGLE
Microflex Reset Timer



FOR MACHINE AND PROCESS CONTROL

Insures "20-to-1 ratio" accuracy

Time settings of pinpoint accuracy are a reality, thanks to the Microflex double dial. It takes one complete turn of the *inner* dial to advance the *outer* dial just one division. That's a 20-to-1 ratio, made possible by the patented Microflex threaded axle and pinion (see sketch). Examples of resultant accuracies are ± 1/60 of a second on a 20-second dial, and ± 1/10 of a second on a 120-second dial.



The Microflex Reset Timer is driven by a heavy-duty industrial synchronous motor. Contacts are tripped closed or open after a preset time interval. Starting and resetting are electrically controlled. Microflex offers over 150 timer operating combinations, plus a wide range of long or short time periods. It's ideal for applications like molding presses, dielectric heating, automatic mixing, die casting machines, machine tools and rubber curing.

Write for free Automation Booklet and Bulletin 110.

EAGLE TIMERS SAVE TIME . . . SAVE MONEY

EAGLE SIGNAL CORPORATION
Industrial Timers Division
MOLINE, ILLINOIS

MAIL COUPON TODAY

EAGLE SIGNAL CORPORATION
Industrial Timers Division, Dept. A-1156
MOLINE, ILLINOIS

Please send free Automation Booklet and Bulletin 110 containing complete data on Microflex Reset Timers.

NAME AND TITLE

COMPANY

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CITY ZONE STATE

bution; inventory control and requirements planning; budget and appropriations accounting; and production control.

Another model of the magnetic disk storage unit is used in the 650 RAMAC. Primarily, this unit represents the basic IBM 650, a medium sized computer, equipped with random access memory means. The memory device for this purpose has a storage capacity of 6 million digits. Up to four such devices, representing a possible 24 million digit storage memory, can be incorporated into a single system. This gives random access to a file equivalent to records which could be stored on 300,000 punched cards. Combination of random storage with computer would be of particular value in industry for data processing operations requiring high level computations.

This type of installation can also be provided with up to ten inquiry stations. Each inquiry station, consisting of a modified electric typewriter, can be programed independently to enable individualized communication with the memory device.

Educators Review Automation —Anticipate Social Effects

AFTER AN INTENSIVE study of automation, the National Conference of Professors of Educational Administration expressed its belief in a series of statements representing the general judgment of the members of the conference. The beliefs are important primarily in indicating the direction of thinking of the educators with respect to the impact automation will have on society in general, and educational institutions in particular.

What does the NCPEA believe about automation? In part, they believe:

— That the chief limitations upon the extension of automation are not technical but human.

— That automation will make it increasingly necessary that satisfaction be found in the job performed and in the many other activities that will occupy much of the individual's time.

— That the progressive shortening of the formal work day, with the accompanying readjustment in time commitments, will result in

AUTOMATION was the dominant theme of the Tenth Annual Meeting of the National Conference of Professors of School Administration which convened on the campus of the University of Arkansas. The annual conference brings together educators for the purpose of exchanging ideas on matters of importance to school administrators. Key figures at the conference were: (Left to right) Dr. John H. Fischer, Superintendent of Public Instruction, Baltimore, Md.; Herman Limberg, Senior Management Consultant of the Div. of Administration of the Mayor's Office, New York City; Dr. Walter D. Cocking, Editor of *The School Executive;* and Roger W. Bolz, editor of *AUTOMATION.*

a school-family unit in which there will be a realignment of educational activities with the family unit assuming increasing emphasis and responsibility.

— That the utilization of automation in the processing of data enhances the prospect of reducing cultural lag.

— That the educational programs in an age of automation must be made increasingly sensitive to the educational needs of adults as well as children.

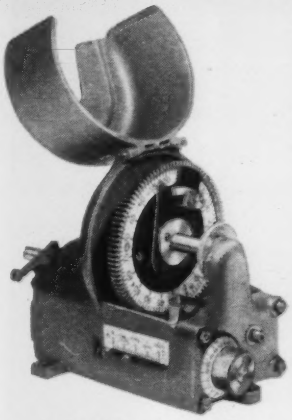
— That school programs must increasingly educate for the intelligent consumption not only of goods and services, but equally of science, research findings and the arts.

— That increasing productivity both requires and makes possible a higher level of financial support for education.

— That school administrators must be prepared to utilize innovations in data processing, communication, and instructional aids, to the extent that they contribute to the accomplishment of the major purposes of education.

Chairman of the special com-

COUNT-REGULATED CIRCUIT CONTROL WITH AUTOMATIC RECYCLING

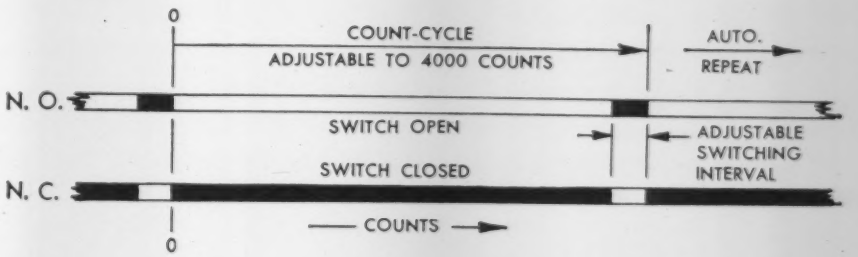


CYCLO-MONITOR
Write for Bulletin 202-1

CYCLO-MONITOR

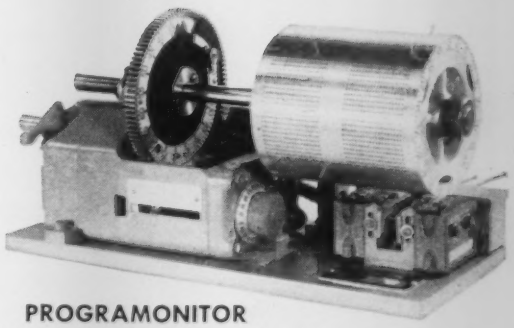
COUNTS: Shaft Revolutions
Lever Strokes
Electric Impulses

CONTROLS: Machines and processes on a repeat cycle basis. No reset required. No pause or lag in recycling—even at continuous speeds. Positive gearing throughout. Integral, SPDT switch transfers as shown in typical cycle diagram below:

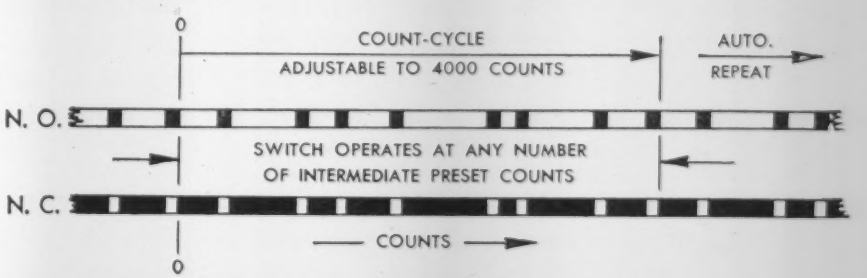


PROGRAMONITOR

An advanced recycling, circuit-controlling counter for complex and irregular switching patterns with any number of intermediate switching points. Complete flexibility for pattern changes. Automatic, instantaneous recycling.



PROGRAMONITOR
Write for Bulletin 505



COUNTER AND CONTROL CORPORATION

5233 W. ELECTRIC AVE. • MILWAUKEE 19, WIS.

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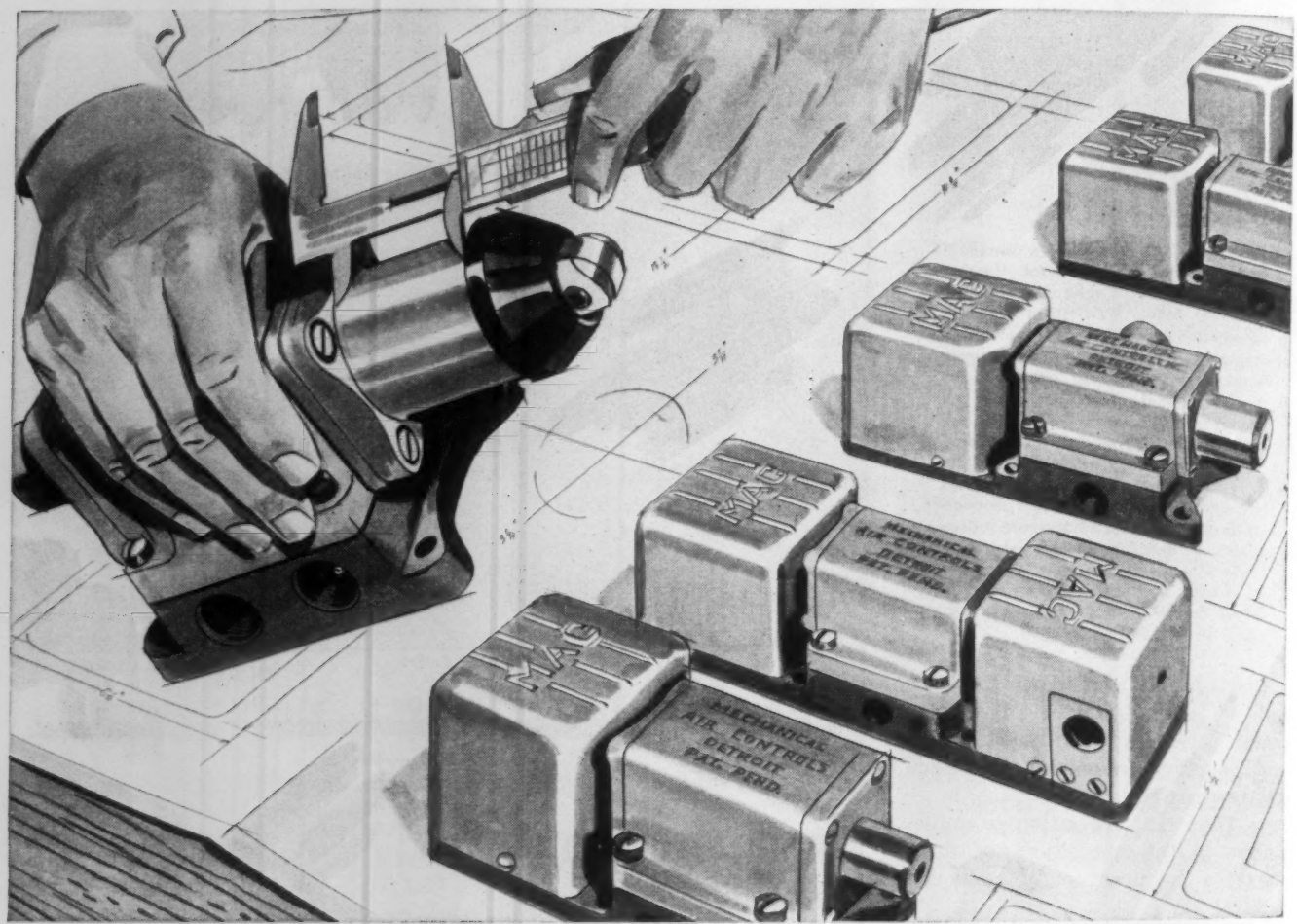
QUALITY IS STANDARD . . . RIGHT DOWN THE LINE



If you walked into our plant you'd hear the rhythm of air valves . . . see machines and men—*just testing!* They're the "fault-finders"—methodically inspecting each MAC valve . . . checking alignment and bore precision . . . hunting a defect in a spring, a faulty solenoid or an imperfect seal. The slightest flaw brings a quick reject. For at MAC we're building *reputation* as well as valves. We make high quality standard on all 98 models.

You'll find MAC valves outstanding, too, for dependability, performance *and value*. They're lighter, more compact, have fewer parts to wear. MAC's simplified design assures millions of operating cycles – with little, if any, maintenance. Small wonder MAC valves are showing up on more and more equipment at tool shows, in shops and plants, *everywhere*.

Why not contact us? We're happy to lend our know-how to any air valve application or problem. There's no obligation, of course. Write for free literature or call one of the MAC representatives listed at right.

MECHANICAL AIR CONTROLS, INC.
10030 Capital, Oak Park, Detroit 37, Michigan

MAC

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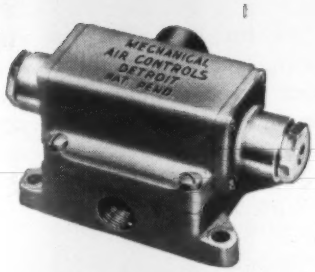

PHONE YOUR NEARBY "MAC" REPRESENTATIVE FOR DATA AND DELIVERY

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OAKLAND 8—The Rucker Co., 4700 San Pablo Ave., OLympic 3-5221
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COLORADO (and NEW MEXICO, UTAH, WYOMING)
DENVER 16—Blair Engineering Co., 4100 Grape St., FLorida 5-7142

ILLINOIS
CHICAGO 43—Mike C. Modrich Co., 10918 South Western Ave., HIlltop 5-3640

INDIANA
FORT WAYNE 3—Neff Engineering Co., P.O. Box 2001, Station A, 2339 Crescent Ave., EAstbrook 7391
INDIANAPOLIS 20—Neff Engineering Co., P.O. Box 7361, 42nd St. Station, BRoadway 2330
SOUTH BEND—Dick Futter, 103 South Varsity Dr., CEntral 2-3800

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BOSTON 34—Electrical Apparatus Co., Inc., 1200 Soldiers Field Rd., STadium 2-7440

MICHIGAN
BAY CITY—Fred Kober, 506 Chilson St., 2-2629
FLINT—Kober Sales Engineering Co., 514 Beach St., CEdar 8-5123
Western Michigan—Everett Adams, 17212 Sharon Road, Chesaning, Michigan; Chesaning 383-J-1

MINNESOTA
MINNEAPOLIS 4—Air Engineering & Supply Co., 2445 Nicollet Ave., FEderal 9-5579
ST. PAUL 14—W. H. Schulz Co., 2438 Franklin Ave., MIdway 4-2791

MISSOURI
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NEW JERSEY (Northern)
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BUFFALO 21—C. H. Tepas Co., 200 Washington Hwy., CIrcle 3210

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DAYTON—The R. W. Nichols Co., 407 Realty Bldg., MIchigan 4724
OLMSTED FALLS—The R. W. Nichols Co., P. O. Box 6, BErea 4-1379
TOLEDO—R. W. Nichols Co., 510 Manhattan Building, Toledo 4, CHerry 1-1447

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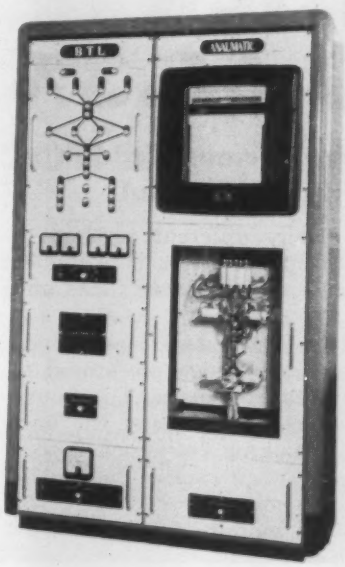
mittee on automation for the conference was **Dr. Walter D. Cocking,** editor of *The School Executive.* The three principal speakers and authors of statements which were circulated to the conference members and which formed the basis for a three-day discussion on automation were: **R. W. Bolz,** editor, AUTOMATION; **Herman Limberg,** senior management consultant of the Div. of Administration of the Mayor's Office, New York City; and **Dr. John H. Fischer,** Superintendent of Public Instruction, Baltimore, Md.

X-Ray Gage In Foil Production

CONTINUOUS CONTROL of the thickness of aluminum foil during manufacture has been achieved by the use of a Pratt & Whitney X-ray gage. Use of the X-ray gage is based upon its ability to detect the presence of metal while ignoring organic materials which are essential in solution during the process of aluminum foil rolling.

A standard Pratt & Whitney X-ray gage is calibrated for a range of from 0 to 0.015-inch of aluminum, permitting direct setting as well as direct reading to 0.00001-inch. Precision of this order of magnitude had previously been possible only by a process involving the accurate weighing of a sample of known area.



AUTOMATIC chemical analysis can be performed by equipment deve'oped by Baird & Tatlock (London) Ltd. The illustrated unit was built with the cooperation of A.E.R.E., Harwell to handle the analysis of uranium liquors. Measured volumes of samples are drawn automatically from four different sources in turn. To each sample, two reagents are added and the mixture is then forced into a mixing chamber and then to an Absorptionmeter where the intensity of the color of the concentration is compared against a standard. The recorder unit indicates and records in four different colored inks the concentration of the samples drawn from the several sources.

MEETINGS AND EVENTS

Nov. 7-8—

Process Data Handling Symposium. Sponsored by Philadelphia Section, Instrument Society of America to be held Bellevue-Stratford Hotel, Philadelphia. Additional information may be obtained from Horace Richter, Fischer & Porter Co., 29 Bala Ave., Bala-Cynwyd, Pa.

Nov. 7-9—

Steel Founders' Society of America. Eleventh Annual Technical and Operating Conference to be held Carter Hotel, Cleveland. Additional information may be obtained from society headquarters, 606 Terminal Tower, Cleveland, O.

Nov. 8-9—

Electronic Business Systems Conference. To be held Sheraton-Palace Hotel, San Francisco. Additional information may be obtained from conference headquarters. P.O. Box 3584, Rincon Annex, San Francisco, Calif.

Nov. 15-16—

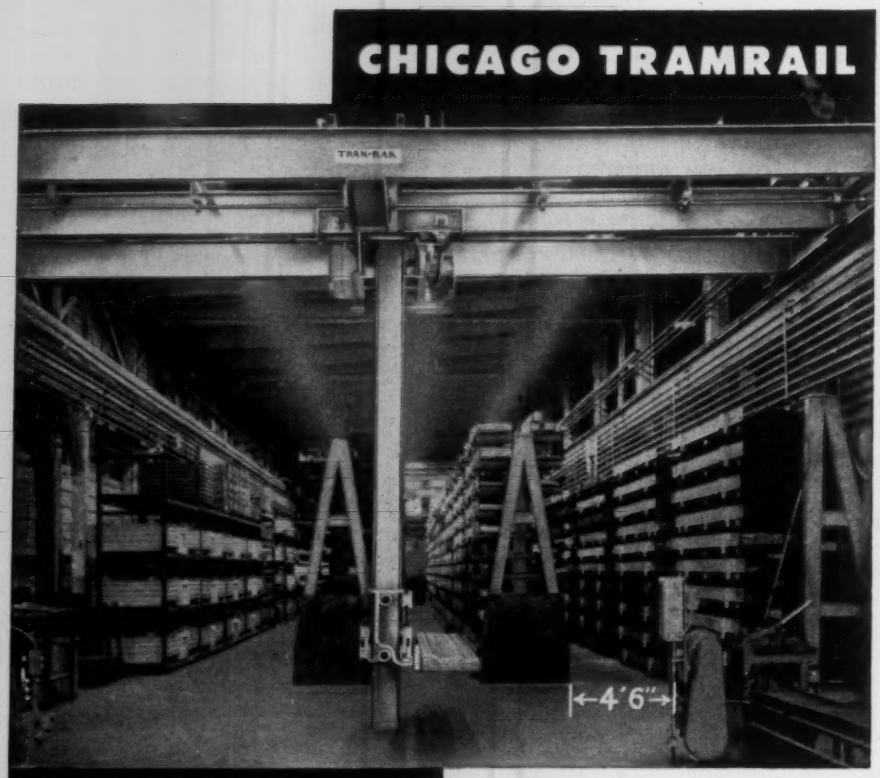
Operations Research Society of America. Tenth National Meeting to be held Hotel Mark Hopkins, San Francisco. Additional information may be obtained from the program chairman, T. E. Oberbeck, U. S. Naval Postgraduate School, Monterey, Calif.

Nov. 26-30—

American Society of Mechanical Engineers. Annual meeting to be held Hotel Statler, New York. Additional information may be obtained from society headquarters, 29 W. 39th St., New York 18, N. Y.

Nov. 26-30—

National Exposition of Power



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BAR STOCK HANDLING 66.3%

employing 2 men where 4 were formerly required . . . with 100% selectivity of material

An improved, simplified, and radically different method of handling bar stock is now in use which replaces the usual difficult and costly method of storing bar stock in pigeon hole racks and removing only a bar or two at a time.

Utilizing the TRAK-RAK Crane System, bar stock is assembled in unit loads placed in containers or baskets which are stored in fabricated tree-type racks on each side of narrow aisles. To remove one or more bars, the container is lowered to the floor, the bars removed and the container with the remaining bar stock placed back in its designated location in the storage racks. The entire movement is one-man, pendant push-button controlled from the floor and it is now possible for the saw man to select his own material and place it directly upon the saw table.

This TRAK-RAK Crane System operates in a 4 ft. 6 in. aisle and stores the material eleven high. The same crane incorporates interchangeable forks which allows the crane to handle palletized material as well as bar stock in the same area.

Write today for TRAK-RAK applications —a 20-page illustrated booklet explaining the TRAK-RAK Handling and Storage System; illustrates and describes installations for handling many diverse materials in fourteen widely different industries.

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and Mechanical Engineering. Twenty-second such national exposition to be held New York Coliseum. Additional information may be obtained from exposition headquarters, 480 Lexington Ave., New York 17, N. Y.

Nov. 26-30—

Third International Automation Exposition. To be held Trade Show Bldg., New York City. Additional information may be obtained from Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 12, Pa.

Dec. 10-12—

Eastern Joint Computer Conference. To be held Hotel New Yorker, New York City. Additional information may be obtained from A. Forman, Room 639, 480 Lexington Ave., New York 17, N. Y.

Dec. 19-20—

Radio - Electronics - Television Manufacturers Association. Symposium on Applied Reliability to be held Bovard Hall, University of Southern California, Los Angeles. Additional information may be obtained from RETMA Engineering Office, Room 650, 11 W. 42nd St., New York 36, N. Y.

Jan. 14-16—

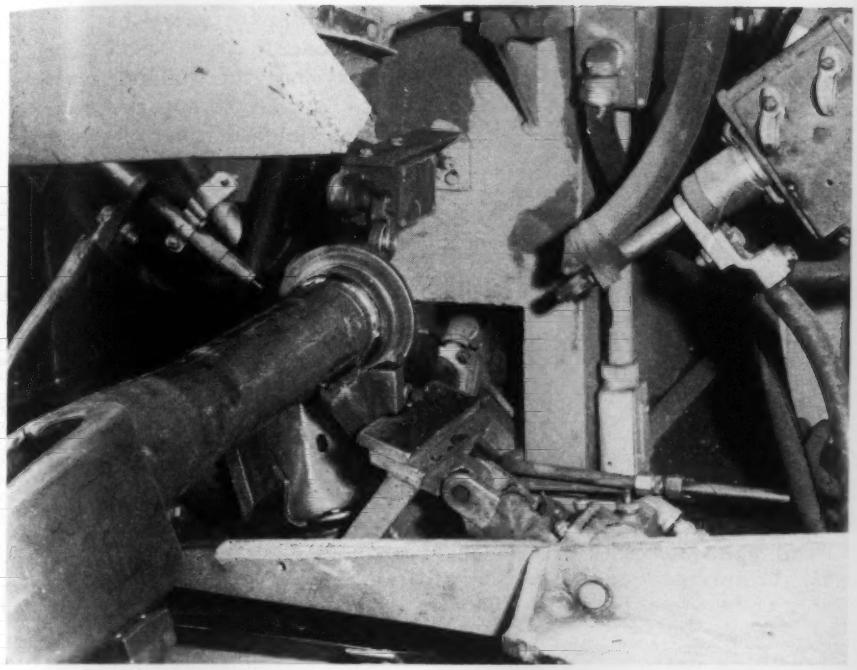
Third National Symposium on Reliability and Quality Control in Electronics. Te be held Hotel Statler, Washington, D.C. Additional information may be obtained from R. C. Murrell, Melpar Inc., Falls Church, Va.

Jan. 28-31—

Plant Maintenance and Engineering Show. To be held Public Auditorium, Cleveland. Additional information may be obtained from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

detroit dateline

By JAMES C. KEEBLER
Associate Editor



Sway bar bracket is welded to Buick rear axle housings at a position 30 degrees below the horizontal. Fixture is shown open for loading. Flux dam provides a static bed of granules at the point of the electrode.

Welded to Automation

THOUGH the 1960 census might find more welding equipment in the back alley shops of the nation than in the production shops of Detroit, it's a lead pipe cinch the automakers are fast closing the gap.

As a claim to fame the blacksmith shop can be listed as the birthplace of production welding, but the demands of automation are giving this technique its place in the sun.

Hot Tip

The welding engineer touts the inside word to the processing engineer that there's a way to spark-em out on a continuous high speed basis that would make Nassau look like a relative of Barney Google and after a short conference with the product designer they're all putting their money on a new welding machine.

Hot tips like this can save a lot of money that would otherwise be spent in making it the hard way. Give this tipster a look at the job when it's in the experimental stages and get a suggestion on how to make it. Let him take a couple sheets over to his smoke filled room and sputter around awhile to see what he can do.

Once you've seen the light and given him the high sign, he'll be more than glad to work with the equipment manufacturer, just to prove out the idea and show you he picked a winner.

Real Hep Cat

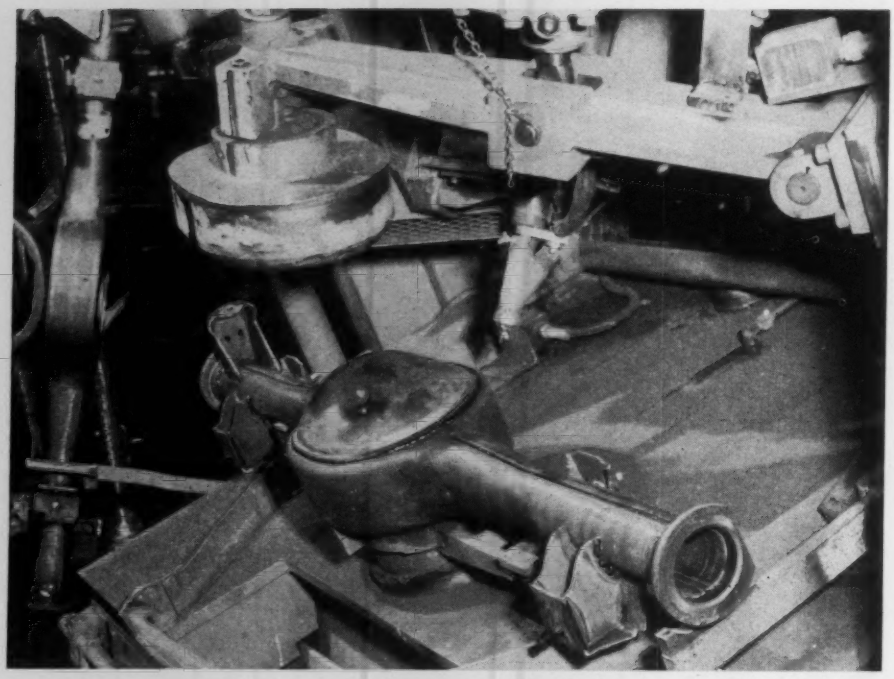
Whether it's flash welding of automobile body fabrications, seam resistance welding tubing for frames, or submerged arc welding rear axle housings, the welding engineer finds himself up to his neck in automation. This rare (high on the help-wanted list) breed of cat actually leads nine lives in his pursuit of automated welding installations. He's (1) A metallurgist, (2) an electrician, (3) a hydraulics specialist, (4) a pneumatics expert, (5) a machine designer, (6) a process engineer, (7) a product designer, (8) an inspector, and (9) a public relations man.

When observed in his natural habitat (the automotive stamping plant) this creature will most likely be seen with a piece of sheet metal in hand scurrying to or from his cage in the corner. In this sanctuary he's king, and has command of enough amps, volts, electrodes, flux and gas to experimentally duplicate any process he's fathering out there on the floor.

To satisfy the need for trained welding engineers the automakers' institutes are training men for this specialty. The halls of higher learning are recognizing that the status cannot long remain quo, and are offering courses in this field. Ohio State University is graduating welding engineers.

Choose Your Weapons

Assuming that you've come to a place in your process where it'd be a darn sight handier to stick two halves together by welding than it would be to try to make it out of one piece, you've only got about four score separate welding processes to choose from. Of course the limited number of these that readily lend themselves to high-production lines narrows the field considerably. At any rate it's a good thing to have one of these welding engineers on the payroll at a time like this so that he can study some of the factors leading



Submerged arc welding machine for welding covers on Buick rear axle housings. Fixture is shown open for loading. Head welds 37 inches of perimeter as the entire workpiece rotates in the machine. Oval contour causes angularity of electrode with respect to weld to change direction four times in one revolution.

to the choice of equipment.

He'll look at such considerations as: What's going to be the reaction of the material when we pour the heat to it? What about pressure, flux, shielding, and filler material? The nine lives within him weigh each consideration and conclude in favor of an equipment recommendation best suited for the job at hand.

The pros and cons are too numerous to list here, but a few items that have been called to our attention include: Manual electric arc welding with coated electrodes is a going high-production process that's going out because it takes lots of manhours to get out production.

Contending for the business is submerged arc welding by machines that feed their own electrode wire, start the arc in a bed of granular flux that they dump along the path which the arc is made to automatically follow, complete the weld and return to starting position. Such a rig zips along at anywhere from 30 to 150 inches per minute depending on metallurgical and physical aspects of the job.

Similar processes shield the metal-arc with inert gas and use either consumable or nonconsumable electrodes.

There may be a possibility of doing the job with resistance welding. Hanging on this family tree are the spot, seam, projection, and flash welding techniques. Resistance seam welding on the Chevrolet-Flint frame line is done with circular electrodes that make 150 feet of welded seam per minute.

Automated to Weld

No matter what the welding process best suited for the job, the desirability of having it automated is great. The first step in accomplishing this is to devise an automatic cycling machine in which automatic welding heads are moved relative to the workpieces by an automatic cycling carriage. Because of the particular configurations of each individual job this leads to special-purpose machines with carriage slides designed to handle a specific job.

Heads may be required to move in cammed relationship to a rotating workpiece, or may be simple straight line traverse and return.

Machine control circuitry requires that the welding head control be wired in as an integral part of the machine control.

Unless extensive tests under simulated production conditions are possible prior to building the machine, variable feed rate is provided so that actual production testing can determine the production setup specifications.

Commonly, the second step to automating the welding operation is to provide for automatic ejection of the finished workpiece from the holding fixture. Depending on part size this may be an air blast or a mechanical linkage.

Generally the last step is to apply automatic hopper-fed loading techniques.

Controlled Quality

Although automatic machine welding can be expected to produce parts of better quality than derived by manual methods, there are control measures at previous operations that are required if best welding results are to be realized. Mating parts must fit with minimum gap specifications. Sheet-metal draw and trim operations must be consistent. To achieve this result stock thickness and springback of metal must meet assigned tolerances.

Cleanliness is a big factor. The welding engineer advises the process engineer on how and when to clean the parts for best results in welding.

Quality of weld is affected by the setup and adjustment of the equipment. For example, once the proper current, voltage, and speeds are determined for a given submerged arc welding job the inspection routine for weld quality is usually a visual inspection of the parts, plus a check that the machine settings are correct. Dimensional checks for proper seating of parts in fixtures must be done with gages.

Precision Production

All this adds up to the fact that automated welding is becoming a precision process, and the welding engineers like Buick's W. F. Williams are helping it along as they devise better ways to do the jobs and observe the trend toward machine tool-precision being built into welding machines.

MICRO precision switches

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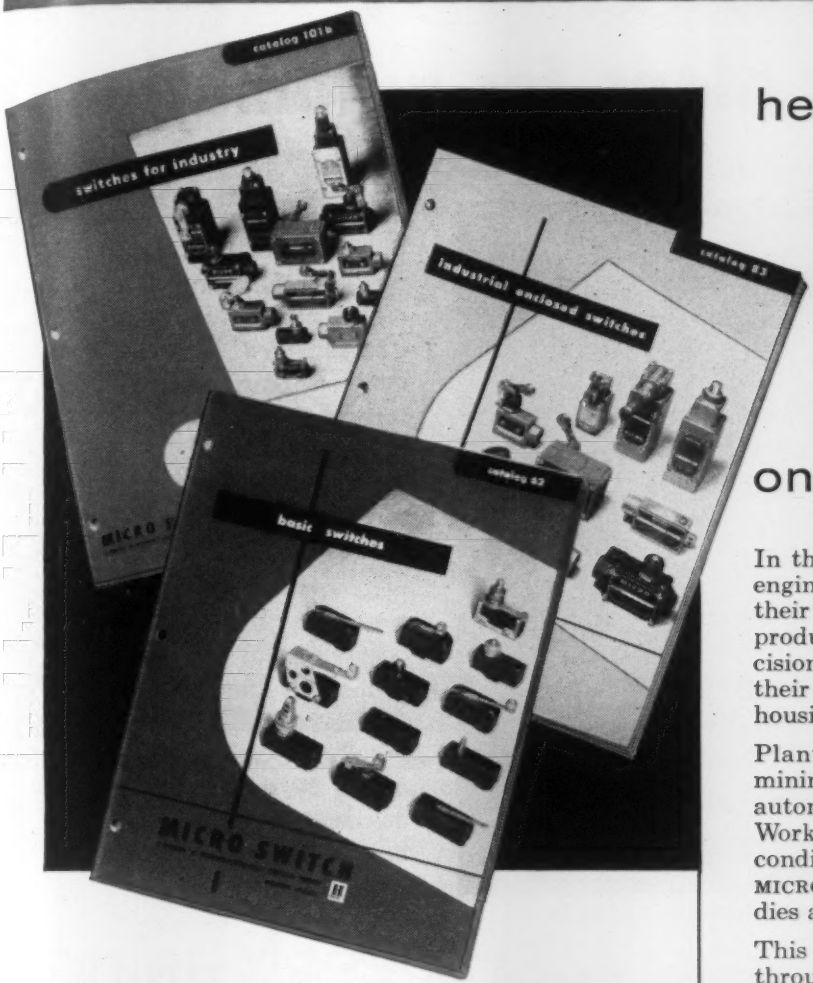

here's the way to BOOST PLANT CAPACITY on a limited budget

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This multiplication of plant work capacity through the use of MICRO SWITCH precision switches is easily done. Products of MICRO SWITCH, a division of Honeywell, are readily available. They are sold by authorized distributors in key cities everywhere.

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Problem—*To shut off motor when oil supply is low.*

Solution—Two HONEYWELL Mercury switches were attached to float in oil reservoir. When re-filling is needed first switch lights a warning light. If level becomes dangerously low, second switch shuts off motor.

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Solution—A MICRO SWITCH metal-enclosed switch is located on sliding sleeve at upper band saw wheel. When sleeve, which indicates tension, travels beyond danger point, switch turns on warning light.

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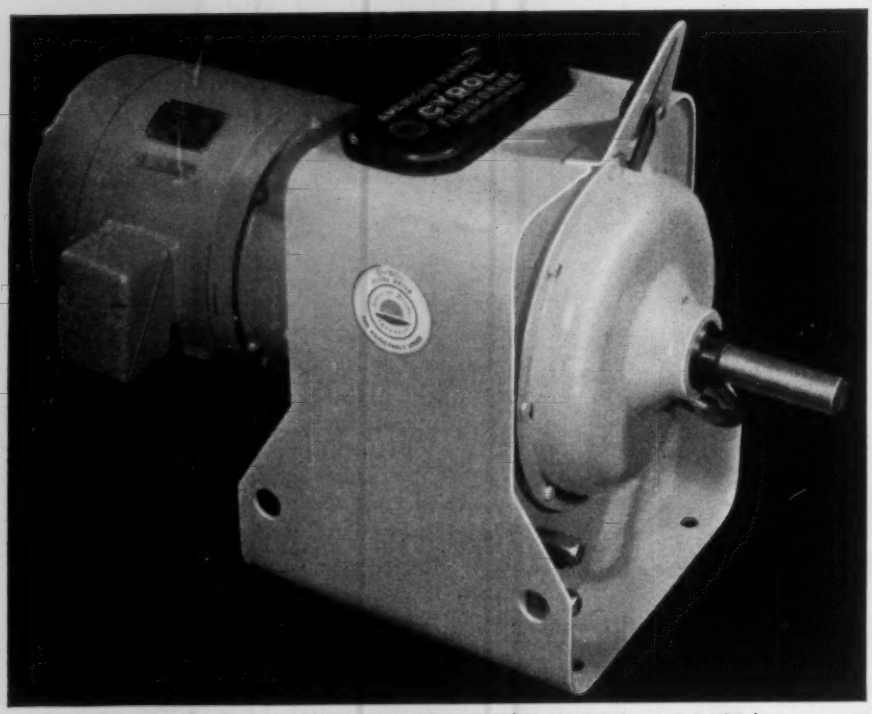
Why you should include Gýrol® Fluid Drives in your plans for automation



Compact, flange-mounted Type VS, Class 2 Gýrol Fluid Drive — 1 to 25 hp.

For one thing, Gýrol Fluid Drives provide adjustable, *stepless* speed control of driven machinery, using *standard*, constant-speed motors — without complicated electric circuits or starting devices.

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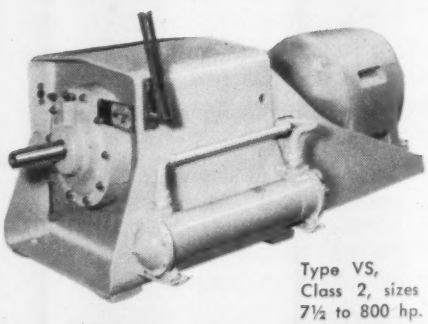

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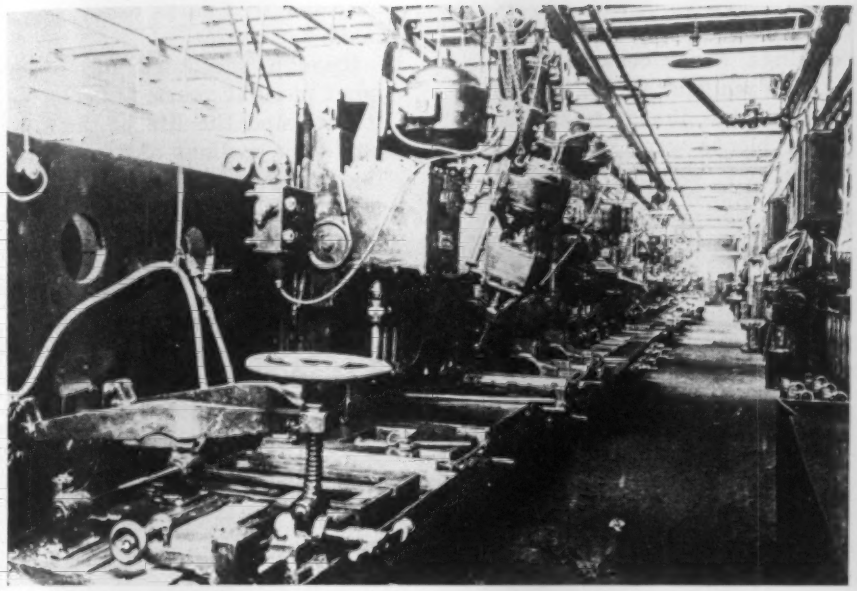
notes from britain

By FRANK G. WOOLLARD
British Correspondent



Photograph of the hand transfer machine, predecessor to the automatic transfer machine, showing some 90 per cent of its length of 181 feet. The station in the immediate foreground is the water test for leaks. The previous station is the cylinder bore finishing head—a rolling operation.

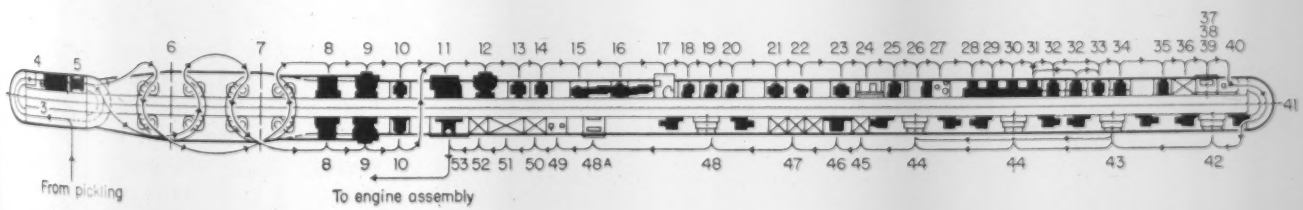
Transfer Machine's Origin

DEVELOPMENT of the automatic transfer machine can, rightly, be regarded as one of the more important steps in automation: hence its early history may be of general interest and also helpful to other pioneers in this most interesting field.

By January 1923 Mr. William Morris—now Lord Nuffield—had acquired from the French Hotchkiss Company the factory in Coventry that had, since the end of the 1914/18 war, been making the engines and gear-boxes for the Morris car. I was appointed General Manager of this Branch of Morris Motors Limited from the same date.

Hotchkiss et Cie., when taken over, had just reached a production of 300 power units per week. This did not satisfy the dynamic Mr. Morris who asked for this output to be stepped up as quickly as possible to 400 and, long before we reached that figure, to 600 and then 800. The factory, which was working on two shifts and overtime, was immediately put on three shifts, but this was insufficient since under our contract we were continuing the manufacture of machine guns for Hotchkiss. Obviously we needed more machinery; but the factory was on an enclosed site surrounded by small property and, while an extension was contemplated, the acquisition of the necessary land was contingent on the re-setting of the occupants of the houses we were to take over: a long and slow process.

A diagramatic plan of the 53-station hand transfer machine. The operations were based on a four-minute time cycle and required 23 operators.



The Idea Is Born

While pondering these problems, during my customary daily walk through the factory, I was joined by the chief engineer, Mr. Herbert Taylor, to whom I said: "I believe that if we were to mount a number of single machine heads on a continuous wall of cast iron with a work table under them, we should have an economical unit which would give greater continuity than our present flow lines and *we should save a great deal of space.*" Taylor responded with: "Have you read my paper to the Production Engineers[1] last year? Because in it I suggested the possibility of an automatic factory with machine units much on the lines you suggest."

Next day he brought a copy of the paper. It showed great originality of mind. We did not, of course, think in terms of an automatic factory, but Taylor was invited to submit a draft general proposition for the first transfer machine. This done and approved it seemed as though we might have to abandon the idea since the builders of standard machine tools, busy with home and export orders, could not be persuaded to

embark on this huge piece of specialized plant.

However fortune favored us when we asked for a quotation from the Black Country firm of Wilkins & Mitchell Ltd. whose managing director, Mr. Walter Wilkins, was a man who thrived on difficulties. Moreover, his company had been supplying certain machines, which were grouped on a common foundation, for producing railway carriage sole bars and the like. These, it is true, were child's play compared to the cylinder block machine which was to be our first, and perhaps the most important, step towards the transfer machine as we now know it.

Installation of the Machine

The machine was built and delivered to time. Nothing like it had ever been seen before. It was 181 feet long; it weighed 300 tons; had 57 motors with an aggregate of 267 hp. There were 53 operating stations. The machine consisted of a hollow wall of cast iron to which was attached, on both sides, a continuous table to carry the fixtures and jigs while above them were the motor-operated heads that performed the cutting operations. These were set in motion by pushbutton controls. It was intended, eventually, to mount a camshaft over the top of the machine to control all the operating heads on a precise time cycle; but this, owing to the difficulty of obtaining trouble-free castings, never became feasible.

This machine was a hand transfer machine, that is to say the cylinder blocks were lifted on to the table and "skidded" from station to station where they were clamped in the fixtures by manual operation. Nevertheless, this was the father of the automatic transfer machines which were later built to Taylor's instructions.

This first machine was eminently satisfactory. It produced finished cylinder blocks at the rate of one every four minutes. There were a number of eight minute operations, but these were, in effect, reduced to the four-minute time cycle by "doubling-up" the machine heads. The number of operators was reduced from 53 machinists to 23. There were two inspectors and two fitters. The fitters worked at the halfway mark to assemble the bearings which were machined in situ. The last station was a paraffin wash, after which operation the block was delivered to the assembly line as an absolutely complete unit to which only the free parts were added to make the engine.

Though scheduled for replacement in eight years, in actual fact, it outlasted the life of the engine and some sections of it were working thirty years later. It must be admitted, however, that some of the heads were rebuilt during this period.

Time studies on this machine confirmed beyond doubt the suspected inefficiencies that arise from the use of individual machines for long sequences of operations. On this machine one man could load and unload four fixtures on the short-time operation stations. Some of the men walked 2½ miles in the course of a nine-hour day.

This, of course, emphasized the necessity for automatic transfer machines. Two of these were developed and put to work early in 1925. But this is another story which will be told subsequently.

[1]H. E. Taylor, "Factory Planning," Proceedings of Institution of Production Engineers, 1922-23.

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Unique horizontal manganese bronze rotor eliminates tumbling damage to parts . . . gentle enough to hopper glass bottles. Ideal for brittle, hardened bearing races.

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Here and There

● Questions have been asked in Parliament on the subject of automation and I am glad to say that the Prime Minister was very definite in his opinion that automation must come otherwise Britain could not hold her place in the industrial world. It may interest you to know that the Department of Scientific and Industrial Research has produced a paper on the effects of automation, and the Institution of Production Engineers have had an ad hoc committee dealing with the social implications of automation. I have had the pleasure of sitting on this committee.

● As a little light relief, it is interesting to know that workpeople in one of the petroleum refineries have made a claim for "loney money" because in such an automatic factory they are not seeing sufficient of their working colleagues.

At The Crossroads

As plant operations become more and more automatic, there is ample evidence that certain industrial practices will of necessity undergo changes. Often lost in the complex of problems encountered, are such changing functions as those of industrial and management engineering.

In a recent conference program, the American Institute of Industrial Engineers editorialized pointedly:

"How do you *job evaluate* a hydraulic-pneumatic-electronic specialist who maintains a battery of automatically controlled machines? How do you *labor measure* him—or do you? How do you apply *wage incentive* to him—or do you? How about *supervision stimulation*—is the supervisor becoming a manager? How about *cost control*—is labor any longer an adequate common denominator for budgets and prices? Must the industrial engineer re-think his job and focus his activities henceforth on instigation of operations rather than measurement of them? Must he act 'before the fact' rather than 'after the fact'? Must he too become a hydraulic-pneumatic-electronic specialist, and a linear programming and operations research specialist as well? Where do we go from here? The future holds much for all of us—but only if we are willing, ready and able to accept the challenge offered within the field of industrial engineering. We must keep our eyes open. Let's not stall at the crossroads."

These questions are well taken. Where do we go? Perhaps now is the time to begin the re-evaluation necessary to insure the kind of future results expected. Conventional methods have been proved inadequate.

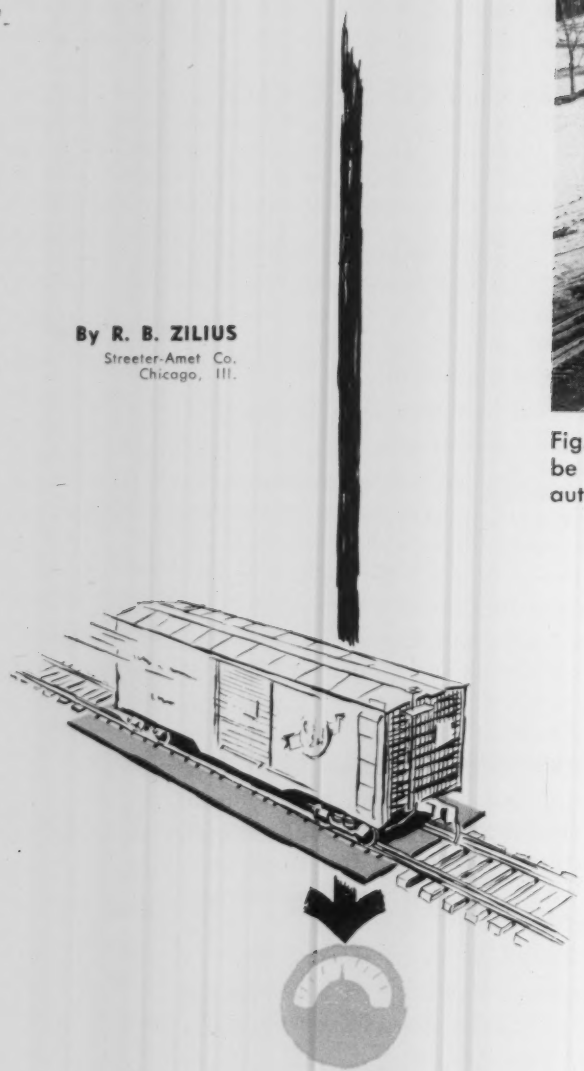
We must answer the challenge with study and research. Tomorrow's engineers and managers must be educated today. There's no need to stall at the crossroads.

EDITOR

AUTOMATION

By R. B. ZILIUS
Streeter-Amet Co.
Chicago, Ill.

Fig. 1—In this modern railroad classification yard the cars can be automatically weighed as they roll down from the hump to automatic speed retarders before switching to selected tracks.



IN-MOTION WEIGHING

Weighing of cars is a basic railroad operation; increased efficiency in this operation means real dollar savings in freight handling costs—and expedites car movements. Using load cells as the sensing device, an automatic scale which weighs cars in motion is described in this article.

RECENT ADVANCEMENT in the control art in the railroad industry is represented by the number of new automatic freight-yard classification installations springing up throughout the United States. As the railroads change over from manual to automatic control in classification yards, the capacity of the yards is greatly increased, and all pertinent data is gathered and forwarded to control centers, enabling faster movement of freight to its destination with lower operating costs.

One of the key operations in the modern freight yard is the weighing of the railroad cars. As the cars enter a yard they pass over a scale, *Figs.* 1 and 2. After weighing they are routed to selected sidings or storage tracks by automated classification equipment. Cars vary in length, weight, contents and type (gondola, flat, tank, box); and versatile as well as rapid weighing is required to efficiently utilize automatic classification equipment.

Conventional mechanical scales, in use throughout the United States today, consist of a system

of levers which allow a large force to be balanced by a much smaller force. As a rule, the balancing force is applied either in the form of a known mass placed on a beam or by deflection of a spring. A weigh-master operating a beam type balance moves the poise out to balance the load. If he overruns, he will move the poise back slightly until a correct balance is obtained. The entire operation may be duplicated automatically. However, inertia and time lags in mechanical systems limit their desirability for automatic installations.

A recent step toward automation in weighing is the development of a high-speed motion weighing track scale built by Streeter-Amet Co. The unit is designed to operate from electrical strain gage load cells rather than from beam and lever systems which are utilized in a mechanical weighing operation. The strain gage load cell does away with the bulky levers and high maintenance costs required to keep the mechanical lever systems in operating condition, and does not sacrifice accuracy for speed.

In the load cell system, weight applied to the cells upsets the electrical balance of a Wheatstone bridge circuit, *Fig.* 3, and establishes a voltage signal. This signal is amplified and energizes a servomotor which positions a data presentation device and simultaneously adjusts a precision potentiometer to again balance the Wheatstone bridge circuit. In print-out devices the servomotor can position a series of step cams and typewheels. A print hammer can then imprint the weight on a tape or ticket. Equipment such as readout mechanisms, punch tape, teletype, IBM card systems and other machines are easily installed to complement the motion weighing track scale. Telemetering systems can also be used with the track scale for transmission of information to remote central locations.

▶ Application Illustration

The installation illustrated in the accompanying photos is a combination arrangement located in the Kirk yard of the Elgin, Joliet and Eastern Railroad at Gary, Indiana. This installation combines two independent weighing systems—a mechanical beam system and a load cell system. The two systems can be worked either separately or in conjunction with one another. As shown in *Fig.* 4, the load cells support the weigh bridge carrying the tracks over the scale and the mechanical lever system supports the load cells. As far as the load cell system is concerned everything below the load cells is merely a base for the cells. This installation uses 16 load cells mounted in pairs, each cell having a capacity of 100,000 lb. Single cells of 200,000-lb capacity could have been used, but pairs of smaller cells were used to increase mechanical stability.

Weigh-beam of the lever system and the instrument console of the load cell system are installed within the same scale house, *Fig.* 5, an arrangement which permits comparative weighing with the two systems for test purposes. The desk unit has all the operating components built into the drawers and top. A cable from each load cell runs into a conduit which connects to the desk unit. The printer unit with the step cam system is re-

WITH AUTOMATIC LOAD CELL SYSTEM

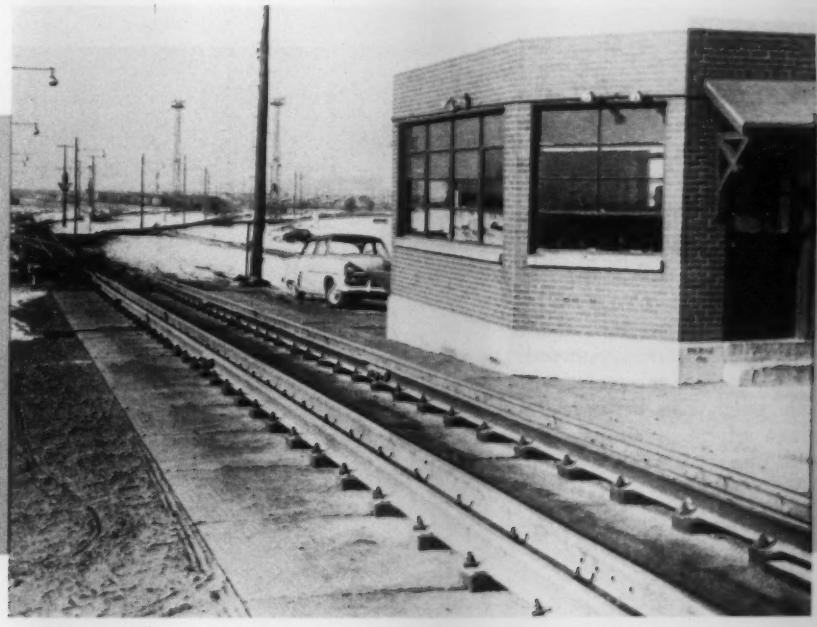


Fig. 2—Scale bridge in the foreground carries the live or weighing rails. The alternate parallel rails are supported independently and carry non-weighers over the scale. The weigh-master oversees the operation from the windows shown.

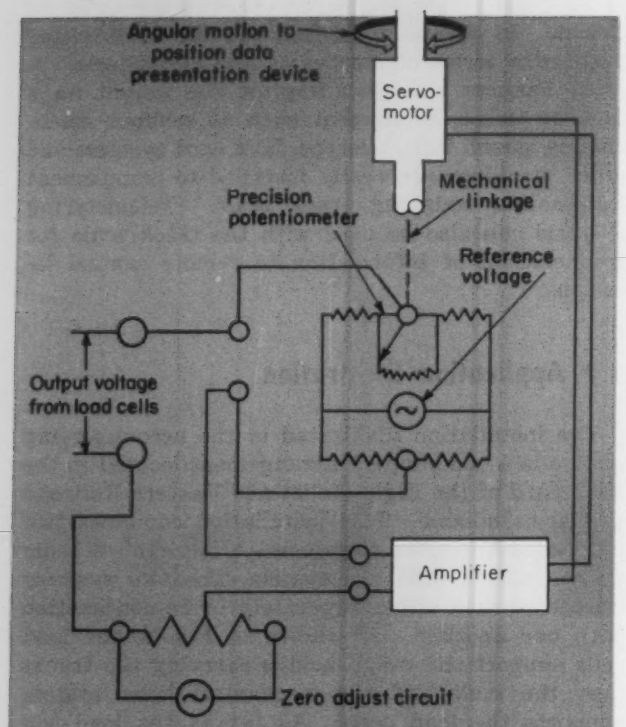


Fig. 3—Simplified diagram of recorder positioning mechanism which positions data presentation means in accordance with electrical signals from the load cells supporting the scale bridge.

cessed into the center of the desk top. By removing the top cover panels and corner screws, the complete printer may be removed from the housing in a few seconds for servicing. Most of the operating units are of the plug-in type and can be readily removed and replaced in a matter of seconds. Spare parts are mounted next to the operating components such as relays, power supplies, and step switches. For ease in locating trouble, all circuits are fused and have signal lights to identify the trouble circuit. The unit design cuts down on possible obsolescence costs by making the equipment readily adaptable for future systems.

Operation Sequence

As cars come up the approach track to the hump, a switchman begins the routing and weighing operations. He decides whether the car is to be weighed; if it is, it must be rolled over the hump on the live rail of the scale, if it is not to be weighed it is rolled over the hump on the dead rail. Yard position, speed, and track location for car destinations are automatically controlled, merely by the switchman selecting the track to which the car is to go.

The whole weighing operation is clearly visible to the weigh-master who is seated at the desk in the office. The weigh-master zeroes the scale prior to weighing cars so that the first printed figure on the tape starts out with 0000.00. This is done manually by depressing the zero adjust switch, then the print switch. All car weights are printed automatically and cannot be printed manually under any circumstances.

Cars approach and pass over the scale at approximately 4 mph on a 3 per cent grade. When a car is routed over the live or scale supported rails, the trip lever visible in *Fig.* 6 is operated by the flange of each wheel passing over it. As the first wheel contacts the trip and enters the scale, the recorder mechanism begins to move toward its position for total weight of the car. As the second and third wheels contact the trip the recorder continues to move toward the total weight position. When the last wheel of the car to be weighed has entered the scale a timing cycle is initiated. In the timed interval after the car is scale borne, oscillations are damped and the recorder is positioned to accurately record the total weight of the car. When the timed delay

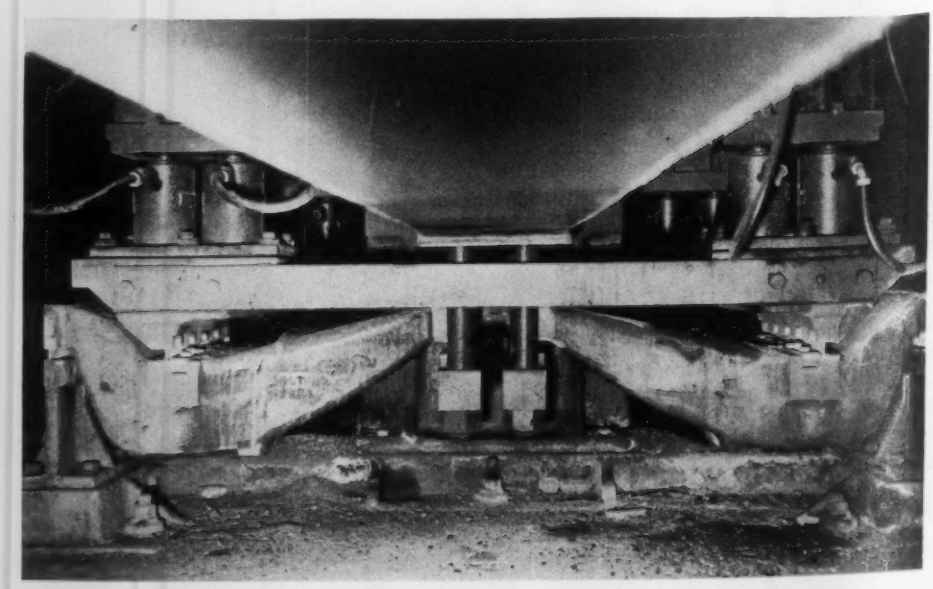


Fig. 4—View in the scale pit looking lengthwise of the scale bridge shows four of the load cells supporting the scale bridge. In this installation the load cells are in turn supported by a mechanical scale system which can be used in place of or in conjunction with the load cell system.

Fig. 5—Weight of a car on the live rails is indicated to the weigh-master on a dial and also automatically printed on a paper tape which feeds out on his desk top and has space for notes as to car number, identification, etc.

ends, the weight is automatically printed on a tape 5 inches wide and the tape is advanced to a position where the weigh-master can write in other pertinent data such as car number or identification. Space between printed weights is also sufficient to allow subtraction of tare weights to obtain net weights.

For this installation, 3 seconds is the time for which a car is usually scale borne before its weight is recorded. Cars over 52½ ft long are not scale borne a full 3 seconds, however, so an alternate 2½ second delay is also available. The weigh-master depresses a foot pedal under his desk when he wants only a 2½ second delay. Weights taken on a 2½ second delay cycle are automatically printed as on the 3 second delay cycle, and are also specially marked to indicate the shorter weighing time. The next car weighed is again weighed on the regular 3 second delay cycle unless the weigh-master again depresses the pedal.

After passing over the scale the car picks up speed traveling down a 6 per cent grade to the first retarder which is located approximately 30 ft from the scale. By means of retarders the speed of a car is automatically reduced to a desired rate based on car weight and yard destination selected by the switchman. Oil on the wheels, various track conditions and other variables may cause the automatic retardation to be inaccurate. For this reason a retarder operator stationed in a tower overlooking the yard and hump has an indicator showing speeds and can override the automatic control, setting up higher retardation or changing the routing if an emergency arises or the previously selected track area is filled.

When a cut of cars has been weighed, the weigh-master again obtains a zero print. He then depresses the tape advance switch and advances the tape far enough to tear off the section with the weights so they can be attached to other records. The same sequence is followed for each cut of cars in which there are cars to be weighed.

Throughout the period of studies and tests conducted on the dual installation there were no failures or breakdowns of any components of the Kirk yard scale. Nor were there any corrective adjustments necessary except for occasional correction of zero balance, which is common to all weighing machines. Problems such as elimination of moisture from parts, shielding of cables, and eliminating effects of stray electric currents created unforeseen factors, and special equipment had to be developed to solve these problems. Now that it has been accomplished, railroads have available a further modern tool to boost the efficiency of their operations — a common industrial goal.

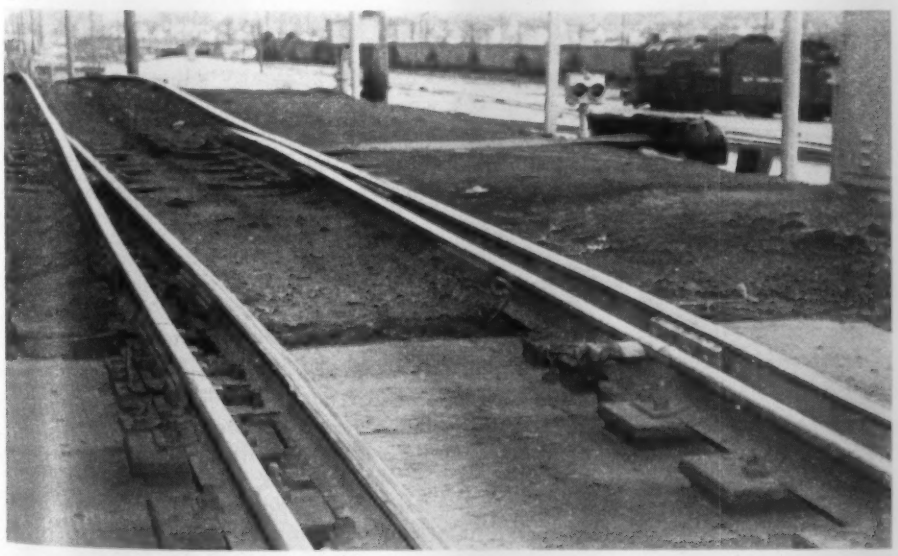


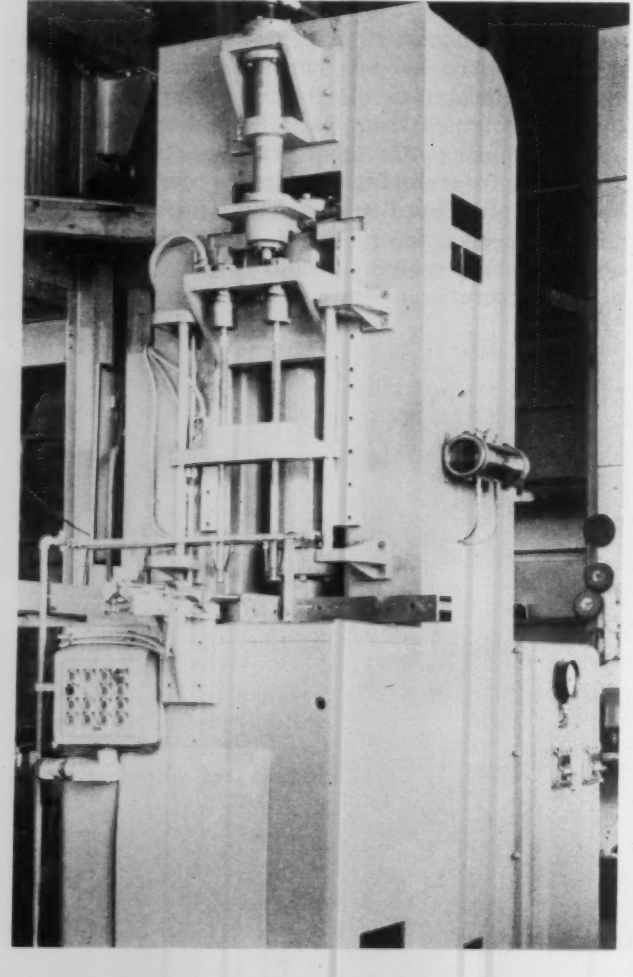
Fig. 6—Flanges of wheels passing over the scale on one of the live rails depress the trip lever shown. When the fourth wheel trips the lever the car weight is automatically recorded after a timed delay to allow for damping of vibrations.

AUTOMATION TODAY

AUTOMATED SPLINE BROACHING

AUTOMATIC CYCLING machines that make slaves of men who serve their working days by loading and unloading parts at a speed necessary to keep pace with the machine have ofttimes been cursed by sociologists as the demons of the age of mechanization. The students of today's trends in automation have heralded modern developments as providing industry's workers with relief from the monotony of being an operating part of an automatic cycle.

More automatic cycling production equipment that is designed to handle high volume production is including the function of workpiece handling as a part of the automatic cycle. An example of this type of evolutionary development can be seen in the process of broaching splines in round holes.



The machining involves pulling or pushing a broaching tool through the successive workpieces of a given production run.

On a vertical pull-down type machine the sequence of operations is to: (1) Place the workpiece in the work station, (2) insert the broach into the workpiece so that the pull end of the tool engages in the puller below the work station, (3) pull the broach down completely through the workpiece, thereby cutting the splines in the hole, (4) remove the workpiece, (5) return the broach puller to the *Up* position, (6) remove the broach from the puller and repeat the cycle. In an unautomated state, the down and up motion of the broach puller performs automatically, and the handling of the broach into and out of the puller is performed manually and so is the handling of the workpiece.

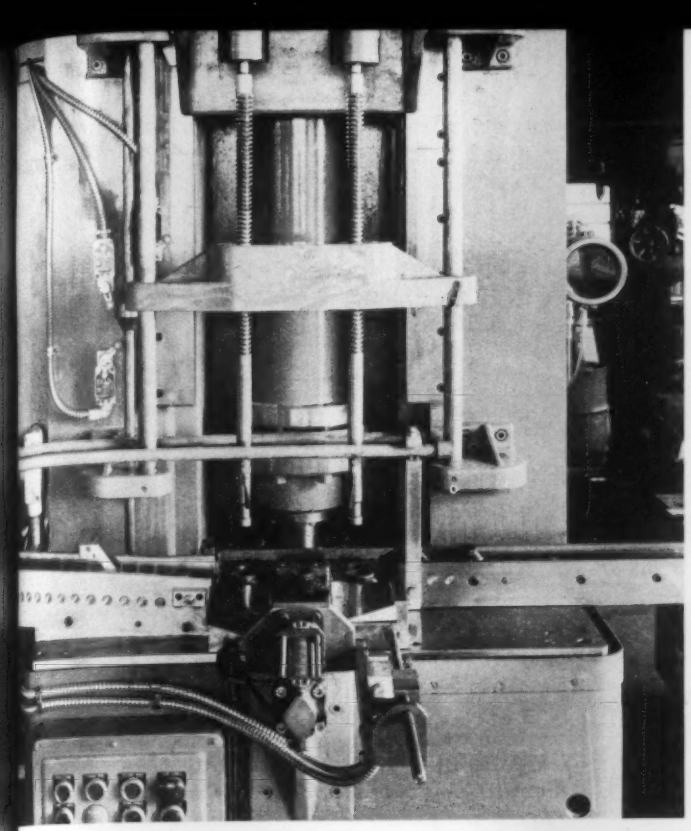
In such an instance the machine can be said to function automatically, but will do so satisfactorily only if the operator is keeping pace by manually handling the broach and the workpieces.

As the economic considerations of production warrant, this type of process can be upgraded by including more of the elements of the operation in the automatic part of the cycle. First step is automatic handling of the broach. This is accomplished by use of a retrieving head on the top side of the work station. This device engages the rear pilot of the broach as the puller head returns the broach through the work station and holds the broach suspended above the work station while the next workpiece is loaded.

Further automating of the process is accomplished by use of automatic workpiece handling equipment. This mechanically places each workpiece in the work station before the broach comes down and removes it before the broach comes up. When the loader is fed by conveyor and delivers the finished work to a conveyor, the responsibilities

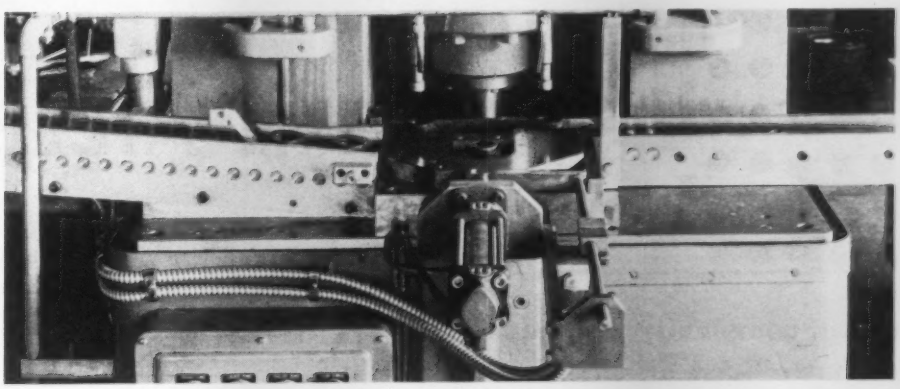
1

Two-station vertical pull-down internal broaching machine developed by Acme Broach Corp. has automatic cycle that includes handling broaches into and out of pullers and handling of transmission components into and out of workstations. Machine cycles automatically, feeding, broaching, and ejecting the completed parts at a maximum rate of 250 parts per hour.



2 Closeup view of tooling station shows automatic fixture, consisting of a left-to-right slide and front-to-back loading slide. Parts are fed from conveyor at left into position in front of loading slide which is shown in retracted position. Spline broaches are in *Up* position, held clear of work station so that workpieces may be loaded.

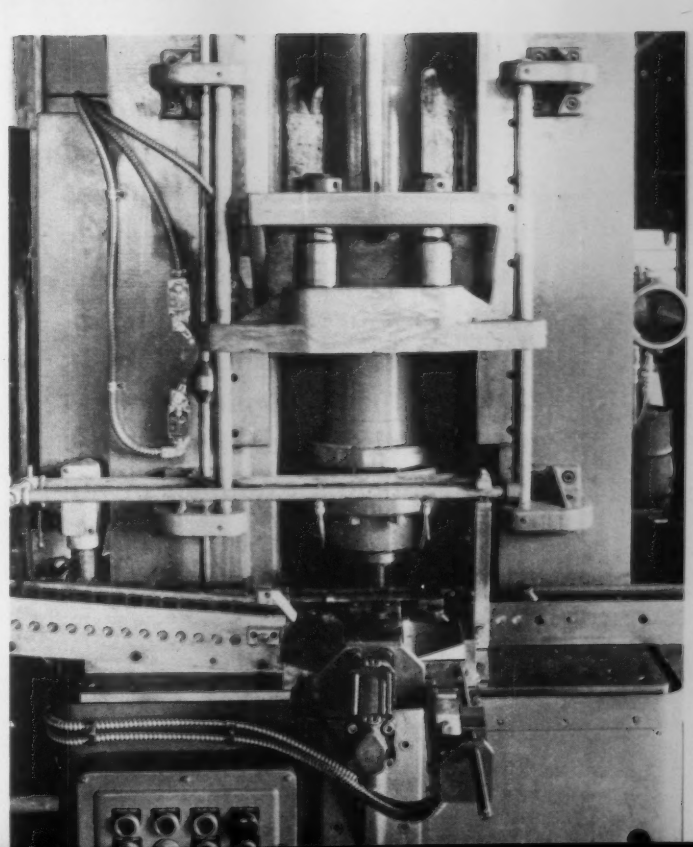
Loading slide pushes two pieces at a time into position under broaches. Retriever heads then descend and deliver broaches through the workpieces. Broach ends engage in puller heads below the table and pilot diameters on the broaches line up the parts. Main cylinder of machine lowers pull heads and draws the broaches down through the parts, thus cutting internal splines. As this happens loading slide moves back out to its retracted position.



3

of the operator become supervisory in nature, inspecting parts as required and maintaining the setup in working order. In special quality control circumstances it may be advisable to incorporate automatic gaging in the discharge conveyor to signal the operator when out-of-tolerance parts are produced.

The accompanying photos show a two-station machine developed by Acme Broach Corp. for automated broaching of internal splines in automotive transmission components.



4 After broaches have reached end of downward stroke and are clear of parts, the left-to-right slide again moves out pushing two completed parts out of the way and bringing additional parts in front of loading slide. Ejector slide then returns back to the left at which time broaches are returned upward through open bores, picked up and raised clear of work station so that two additional parts may be pushed into broaching position by loading slide.

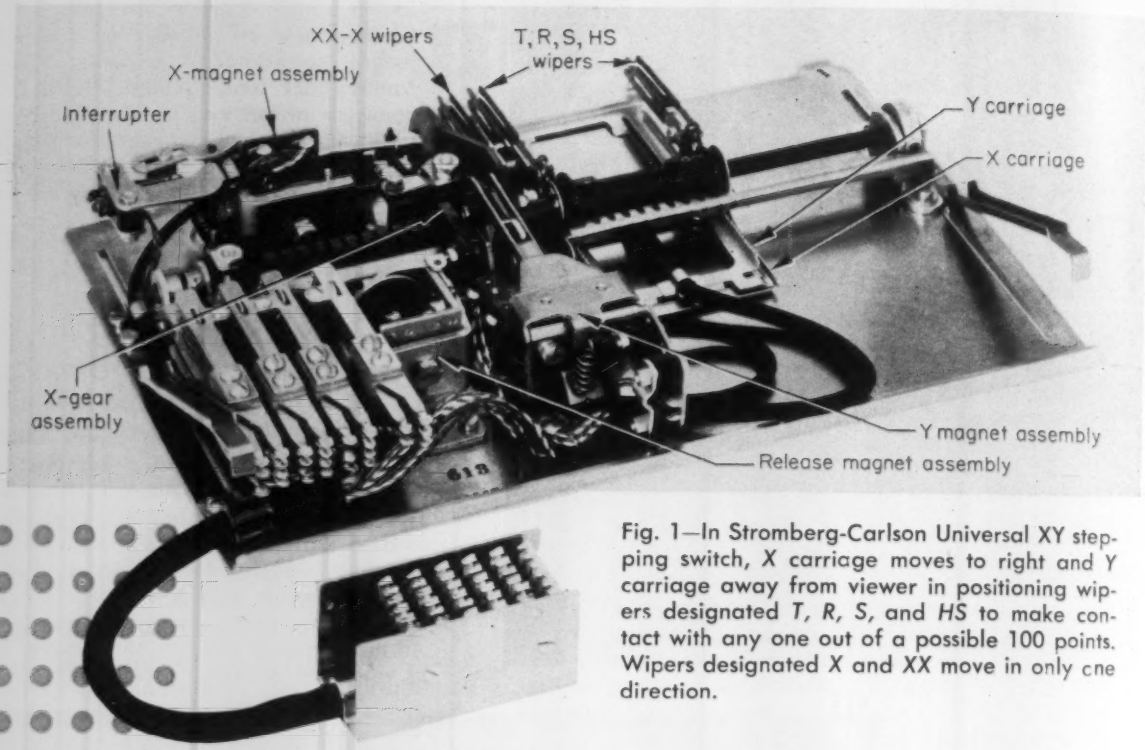


Fig. 1—In Stromberg-Carlson Universal XY stepping switch, *X* carriage moves to right and *Y* carriage away from viewer in positioning wipers designated *T, R, S,* and *HS* to make contact with any one out of a possible 100 points. Wipers designated *X* and *XX* move in only one direction.

APPLYING TELEPHONE

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Growing complexity of industrial control circuits increases the relative importance of switching devices, relays and related equipment to the solution of difficult automatic control problems. Where applications are concerned, no better guide than telephone experience can be found—for over 60 years the industry has experimented with, developed and applied electromechanical devices in engineering outstanding examples of automation.

IN FEW INDUSTRIES has automation achieved as high a degree of development as in telephony. This achievement is exemplified by systems for automatic route selection for long distance calls, and toll ticketing devices which automatically verify and record the number of the party dialing a toll call, the number of the called party, date and time of day, elapsed time of the call, and upon conclusion of the call, compute the charges, making proper allowances for night, Sunday and holiday rates. All this information is finally converted for billing purposes into an automatically typed ticket or punched card.

Not only does automation have a long history in telephony—dating back more than 60 years—but the industry also is by far the most extensive user of relays, stepping switches, and other electromechanical switching devices that are the "work horses" of all electrical automation systems. It is natural, therefore, that the telephone industry should have developed switching devices with special characteristics. Among these products are the "XY" brand of switches, recorders and other devices manufactured by Stromberg-Carlson which are described in this article. Considering the horizontal nature of automation, persons faced

with control problems in other industries may find that some of these devices are of value in the solution of their own problems in automatic control.

Switching Problems Are Similar

The stepping switches, relays and their associated circuits, which will be described in this article, form the nucleus around which *XY* dial telephone systems are built. It is not the purpose of the writer to provide an article on telephone systems, but rather to acquaint those interested in electromechanical switching systems with the apparatus used in telephony, and the way that apparatus is applied. Many of the switching problems encountered by engineers engaged in developing automatic control systems are closely similar to those which telephone engineers have had to solve in developing dial systems.

For example, Stromberg-Carlson's Automation Research Dept. has found telephone type relays and stepping switches useful for controlling both signals and power in automatic equipment. Since heavy duty relay contacts can handle several hundred watts, small motors can be switched directly from contacts on the same relays that handle the control information. In Digimatic, a numerically controlled machine tool system, for example, extensive use is made of relays to provide low cost, reliable control for a high speed, special purpose digital computer (see—AUTOMATION, July 1956). Relays also are used to control small motors and solenoid operated mechanisms on the machine tool itself.

For heavier power requirements relays can be used to control contactors that can handle large currents. This method is used, for example, in an automatic rectifier tester, where currents of the order of 88 amperes must be switched by a control signal of 30 milliamperes.

Relay control also is used to sequence an automatic electronic production line, where control signals are intermixed with power signals that control solenoids requiring 25 watts, as well as magnetic motor starters on 7.5-hp motors. A gang saw, for example, that is used to cut printed circuit boards, must have both these high and low power elements directed through an automatic sequence of operations. Although not all of the machines in the automatic assembly line require that such wide variations of power be controlled,

SWITCHES AND RELAYS

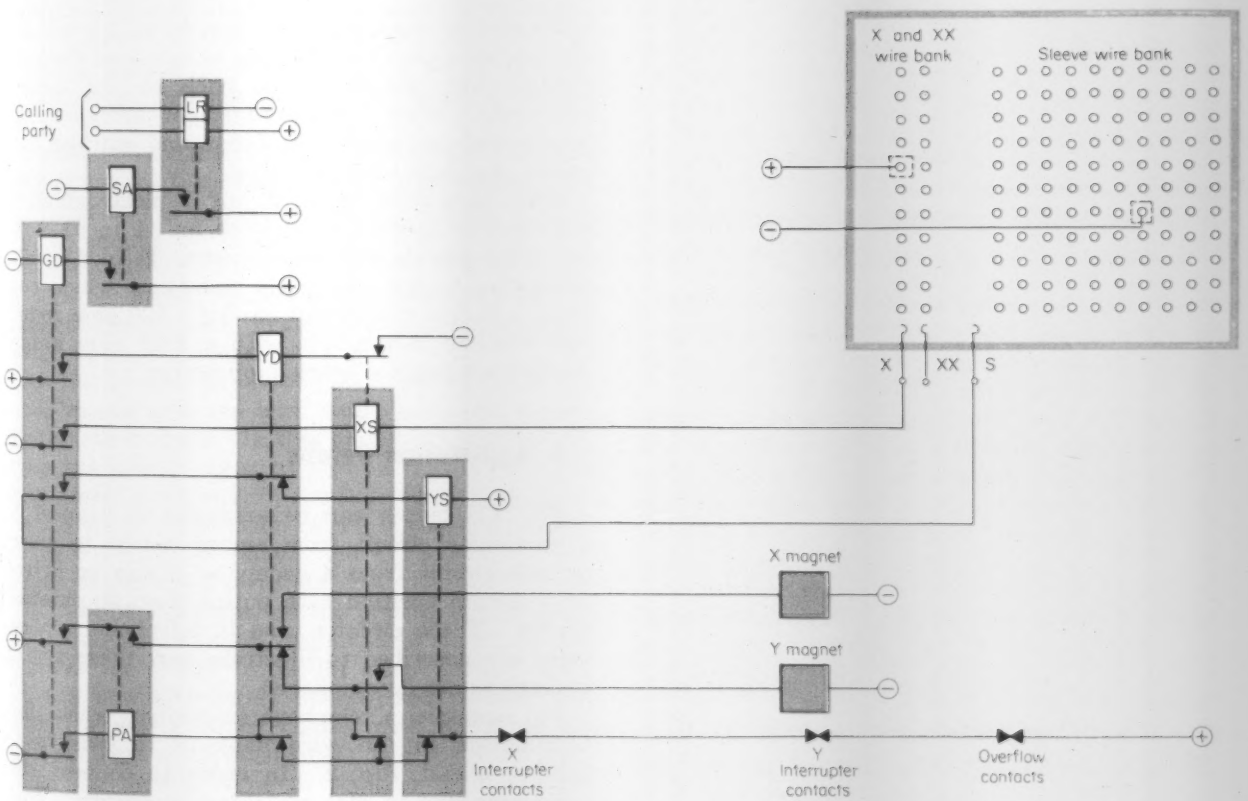

Fig. 2—Line finding circuit illustrates use of relays with stepping switch in typical telephone application. Circuit is designed to connect a single line in the wire bank to dial switching equipment common to the 100 lines.

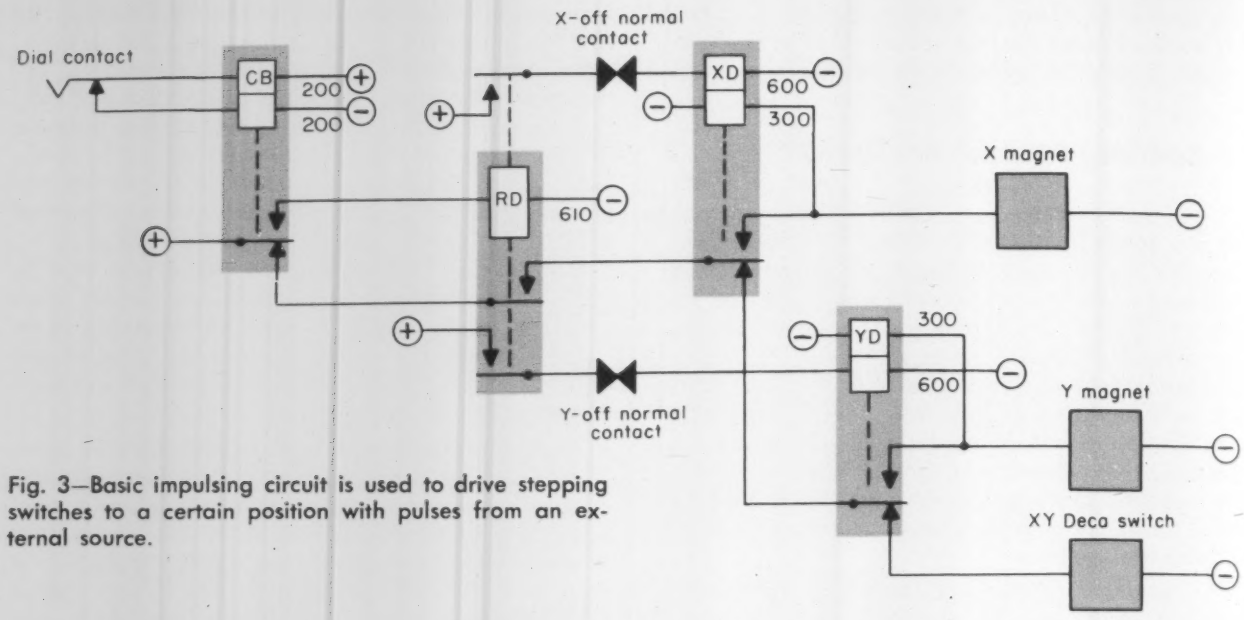

Fig. 3—Basic impulsing circuit is used to drive stepping switches to a certain position with pulses from an external source.

the need to switch power from control signals exists everywhere in the automatic production line, and relays successfully meet the need.

The Universal Switch

The heart of the dial telephone systems built by Stromberg-Carlson is the XY Universal Switch. This form of stepping switch contains elements capable of motion in two directions. As shown in *Fig.* 1, a carriage containing the contacts of wipers moves, first to the right, and then away from the viewer. For convenience, these motions will hereafter be referred to as in the *X* direction and *Y* direction, respectively. Motion in each direction is achieved in 10 steps, and is accomplished by means of electromagnets which are mechanically linked to the carriage.

Since the switch is capable of moving through 10 positions in each of two directions, contact with any one of a possible 100 lines can be accomplished. An eleventh position in each direction is normally used to mark over-travel and initiate release when the switch has checked all levels or positions during hunting operations.

The switch has four wipers which move in two directions, and two wipers (designated as *X* and *XX* wipers) which move in one direction only. One of the four wipers which moves in two directions is called the "sleeve" wiper, and is used for control, while the other three wipers carry other signalling and voice circuits. Since we are concerned only with controls at this time, we shall limit our discussion to the control circuits; only these circuits are shown in the accompanying diagrams.

The *X* and *XX* wipers serve to mark the level of travel in the *X* direction. They step one level into their associated wire bank for each step that the switch takes in that direction. In addition the XY Universal Switch also has:

1. Interrupting contacts on both the *X* and *Y* electromagnets which open when the electromagnet is energized.

2. Off-normal contacts to indicate that the switch has moved from, or returned to the normal position of rest.

3. Overflow contacts to indicate that the switch has traversed to the extremity in either direction.

4. Release contacts to indicate that the release magnet has been energized and the switch is moving to the home position.

Contact between the four associated wipers and any one of a possible 100 lines is achieved through vertical wire banks at the back of the switch mounting. With this arrangement switches can be stacked one above the other and worked into continuous bare wire multiples.

Sixty ohm coils on the *X* and *Y* electromagnets are used to operate the switch on 44 to 52 volts dc. The switch will release with 38 to 53 volts dc applied to the release electromagnet which contains a double wound coil having a 300 ohm inductive winding in multiple with a 2200 ohm noninductive winding for spark suppression.

Application Details

The *XY* switch can be arranged to connect to a particular circuit from among many, to select an idle circuit from a group, or it can be driven to a certain position with pulses from an external source. Three circuits used in telephone applications are described to illustrate how these switch operations are accomplished.

For example, a telephone subscriber, whose line termination in the wire bank is 75, wishes to initiate a call, *Fig.* 2. In order to connect this particular line to dial switching equipment which is common to all lines in the wire bank, the switch must scan all positions until the calling line is found. When the subscriber removes the telephone

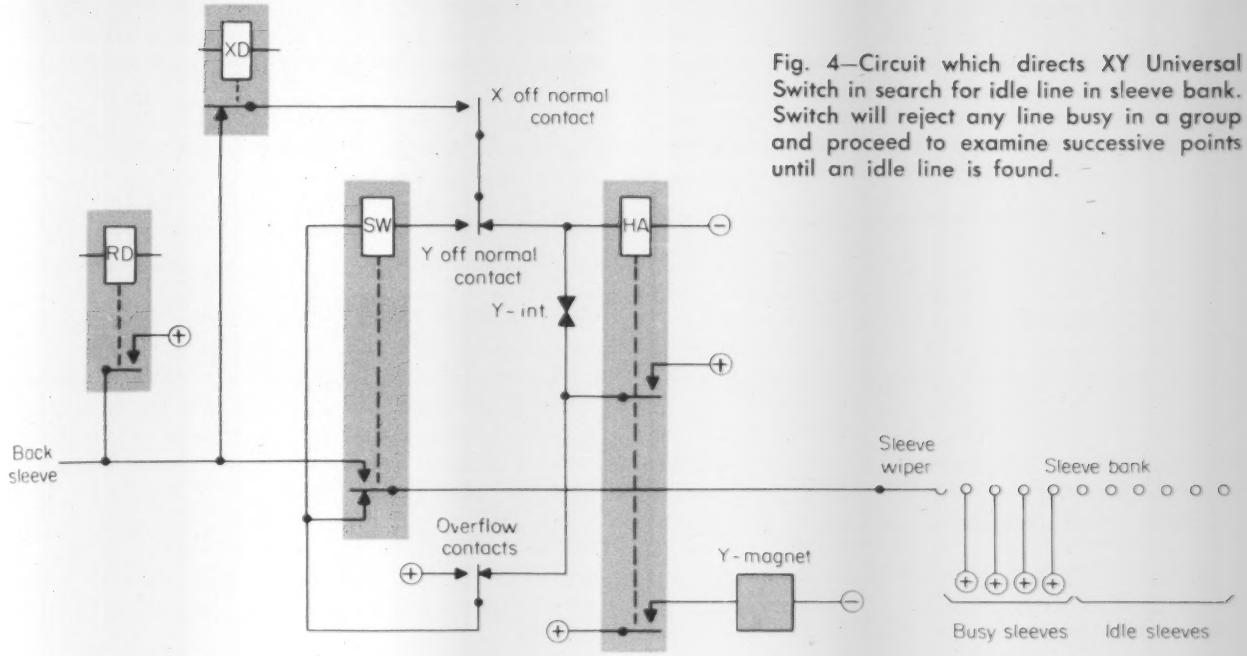

Fig. 4—Circuit which directs XY Universal Switch in search for idle line in sleeve bank. Switch will reject any line busy in a group and proceed to examine successive points until an idle line is found.

handset, a switch in the instrument closes the loop to the *LR* relay. Operation of the *LR* relay in turn places a positive potential on position 7 in the *X* wire bank, and negative potential on position 75 in the sleeve wire bank. This provides a definite marking of the subscriber in the wire bank.

Following operation of *LR*, relays *SA* and *GD* operate successively. Operation of *GD* results in operation of the *YD* and *PA* relays. This energizes the *X* magnet, causing the switch to take one step in the *X* direction. Simultaneously the *X* and *XX* wipers move one step into their associated wire bank.

Interrupter contacts on the *X* magnet open and remove energy from the *PA* relay. Release of this relay opens the circuit to the *X* magnet. When the *X* magnet releases, its interrupter contacts are again closed, and the circuit to the *PA* relay in turn is closed; thus the *PA* relay and the *X* magnet operate on a pulse assist basis to step the switch in the *X* direction.

As the switch moves in the *X* direction, the *X* wiper moves into the wire bank, and checks each position as it steps. In this particular illustration, when the switch steps to position 7, the *X* wiper encounters a positive potential which energizes the *XS* relay. Operation of *XS* opens the circuits to the *PA* and *YD* relays, and the switch will no longer step in the *X* direction.

Release of *YD* transfers the pulsing circuit from the *X* magnet to the *Y* magnet, and simultaneously closes the circuit to the *PA* relay. The *Y* magnet will now alternately operate and release, and drive the sleeve wiper (along with its three associated wipers not illustrated) into the wire bank. When the switch steps to position 5, the sleeve wiper encounters a negative potential. This operates the *YS* relay and opens the circuit to *PA*. Since the circuit to the *PA* relay is opened, the *Y* magnet will no longer operate and the switch wiper will remain at the required position until a switch release occurs.

Dialing Operation

A basic impulsing circuit used to drive the *XY* universal switch to a certain position with pulses from an external source is shown in *Fig.* 3. Proper functioning of the circuit depends on the use of a special pulsing relay (*CB*) and three slow-release relays (*RD*, *XD* and *YD*).

When the *CB* relay is operated as a result of loop closure by contacts within the telephone dial, relays *RD*, *XD* and *YD* are energized. The *XD* and *YD* relays operate on their respective 600 ohm

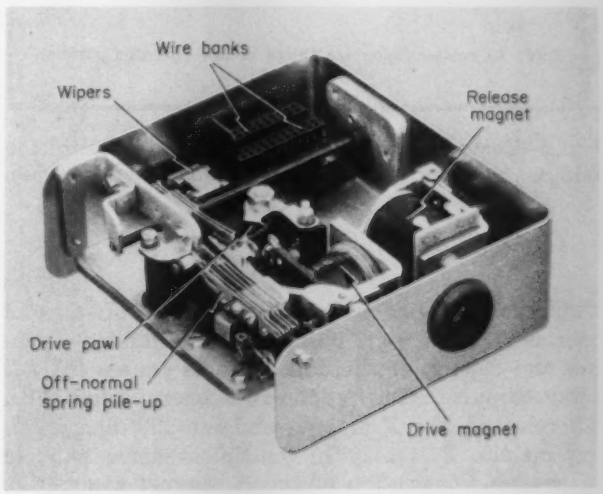

Fig. 5—Direct-drive, reset type switch with ten-point selection over four levels is another form of Stromberg-Carlson stepping switch used in telephone and industrial control systems.

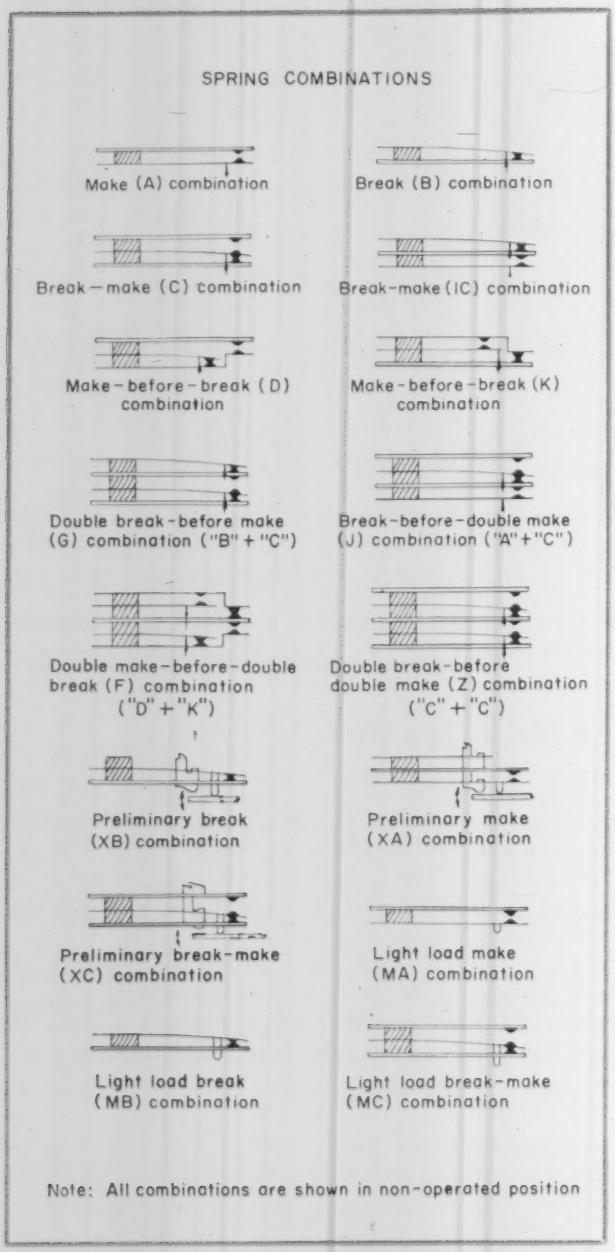
SPRING COMBINATIONS
Make (A) combination
Break (B) combination
Break–make (C) combination
Break–make (IC) combination
Make–before–break (D) combination
Make–before–break (K) combination
Double break–before make (G) combination ("B" + "C")
Break–before–double make (J) combination ("A" + "C")
Double make–before–double break (F) combination ("D" + "K")
Double break–before double make (Z) combination ("C" + "C")
Preliminary break (XB) combination
Preliminary make (XA) combination
Preliminary break–make (XC) combination
Light load make (MA) combination
Light load break (MB) combination
Light load break–make (MC) combination
Note: All combinations are shown in non-operated position

Fig. 6—Common spring combinations used in telephone relays. Switches are shown in nonoperated position.

windings in series with the *X* and *Y* off-normal contacts. As a digit is dialed, the alternate opening and closing of the dial contacts causes the *CB* relay to pulse. During the first open period, with *CB* released, the *X* magnet and the 300 ohm winding on the *XD* relay in multiple receive a pulse of energy. Operation of the *X* magnet causes the switch to take one step in the *X* direction. Since the switch has moved from the home position, the *X* off-normal contacts, in series with the 600 ohm winding on the *XD* relay, are opened. The *XD* relay must now rely upon the 300 ohm winding to keep it operated. The *RD* relay remains operated during this interval due to its slow release characteristics.

During the next interval, when the dial contacts are closed and the *CB* relay is energized, the *RD* relay receives another pulse to keep it operated, and the *X* magnet is de-energized in preparation for the next stepping action. The *XD* relay remains operated due to its slow release characteristics.

As the dial mechanism continues to rotate, this procedure is repeated and the switch steps to the desired level in the *X* direction. When the dial mechanism stops rotating the *CB* relay remains operated. Since the *XD* relay does not receive a pulse within its release time, it releases and transfers the pulsing circuit to the *Y* magnet. Thus, when the second digit is dialed the switch steps in the *Y* direction in a manner similar to that for travel in the *X* direction. The switch is thus driven to make contact with one line in a group of 100.

Open Circuit Searching

In *Fig.* 4, the *XY* universal switch is used to hunt for idle equipment in a given group. The illustrated circuit functions after the switch has been driven to a certain level in the *X* direction, and is prepared to search in that level for an idle line. The control of this circuit depends upon the presence or absence of voltage on lines in the sleeve bank. If the succeeding circuit connected to any step is busy, positive potential is sent back to the terminal in the sleeve bank to indicate to switches searching for idle equipment in the same level that the unit connected to that particular step is engaged. Consequently, if the sleeve wiper encounters positive potential, the switch automatically steps to the next position in search of an absence of voltage.

Operation of this circuit is as follows: *RD* relay is operated. Release of the *XD* relay, after reaching the desired *X* digit, operates the *HA* relay (*X* off-normal make contacts are closed since the switch has moved from the home position in the *X* direction and the *Y* off-normal break contacts are closed since the carriage has not as yet moved in the *Y* direction).

Operation of the *HA* relay operates the *Y* magnet and initiates motion in the *Y* direction. As the switch leaves the home position, the *Y* off-normal contacts are actuated. The *HA* relay is now held operated through its own contact until the *Y* interrupter contacts on the *Y* magnet are opened. *SW* cannot operate during this interval, since the coil is shunted out. When the *Y* magnet is fully operated, the *Y* interrupter contacts open. The *HA* relay and the *Y* magnet release. The switch is now prepared to test step one in the sleeve bank to determine whether it is busy or idle.

As indicated in the accompanying circuit, at step one the sleeve wiper encounters a positive potential which is forwarded to the *HA* relay. *HA*

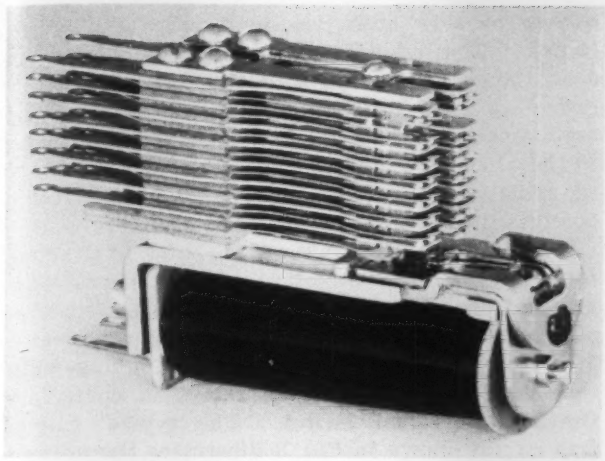

Fig. 7—Most commonly used relay in telephone applications is type A which can contain up to 20 make contacts. Wide variety of relays for special applications can be made from this basic form.

operates and again applies energy to the *Y* magnet, causing the switch to take another step in the *Y* direction. Release of *HA* and testing of position two occurs as above. The switch thus steps past all positions which are busy and marked with a positive potential.

When the switch steps to a position which is idle, the sleeve wiper does not encounter a positive potential and the coil of *SW* is not shunted out. Consequently *SW*, which is now in series with *HA*, operates. However, *HA*, which is designed to operate within closely specified energy requirements, does not operate because of the limited current available. Thus, the switch stops at the first idle position.

The Deca Switch

A second type of stepping switch designed for automatic telephone and industrial control systems is the XY Deca Switch, *Fig.* 5. It is a direct drive, reset type with 10-point selection over 4 levels. The wire bank is the same 11-wire type used on the XY Universal Switch. When in the home position the wipers rest on one of the 11 wires, which may be used for some circuit function.

In telephone systems, the XY Deca Switch is operated on 43 to 53 volts dc by means of a double wound electromagnet. An 87 ohm inductive winding provides the energy for stepping, while a multipled 400 ohm noninductive winding is used for spark suppression. The switch will reset with 38 to 53 volts dc applied to the release electromagnet, which includes a 75 ohm inductive winding in multiple with a 2200 ohm noninductive winding. In telephone applications, this switch is used to apply ringing current of the correct frequency to a party line having a maximum of 10 subscribers. Referring to the basic impulsing circuit shown in *Fig.* 3, it can be seen that after an XY Universal Switch has been driven to the desired position by dialing two digits, the *YD* relay releases and transfers the pulsing circuit to the stepping magnet of an XY Deca Switch. Consequently by dialing an additional pulse, ringing

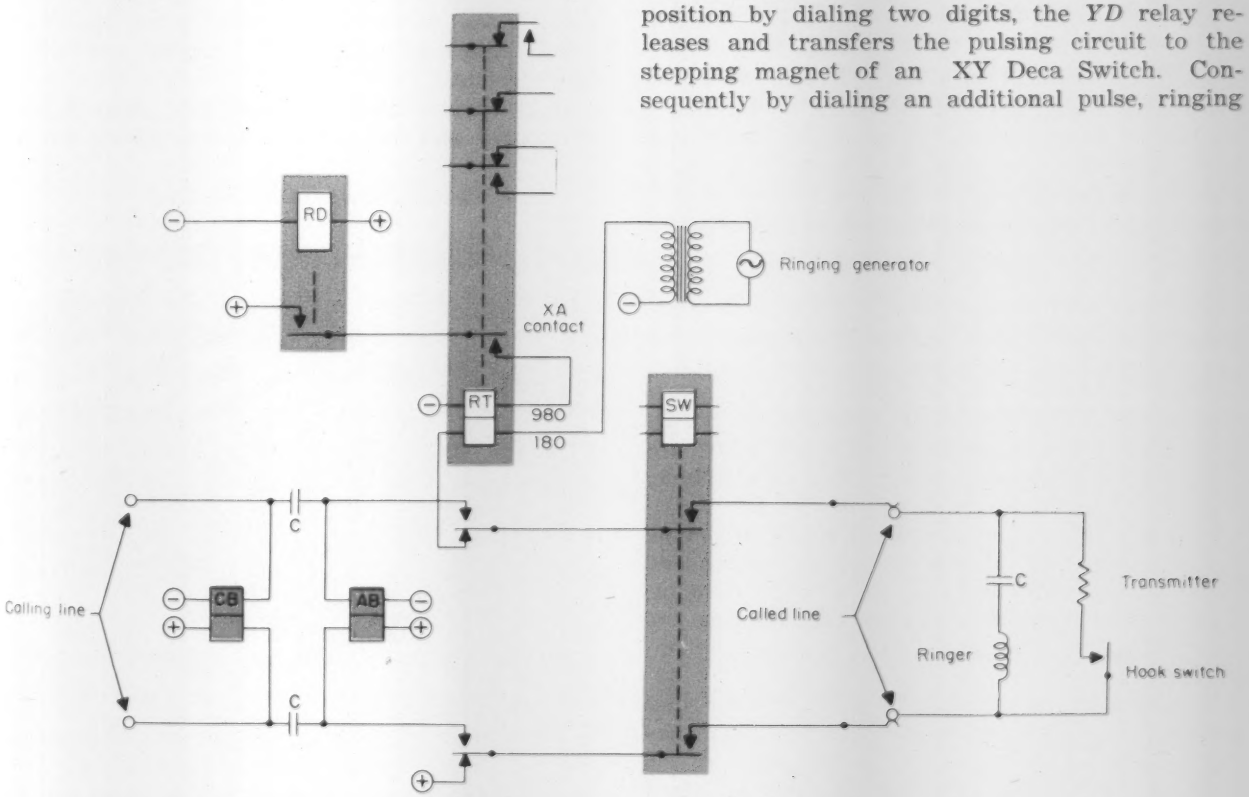

Fig. 8—Ringing trip circuit illustrates use of a slow operate relay *(RT)* with double wound coil. Relay does not respond to ringing signal but does respond to a preliminary make contact which is actuated when called line answers.

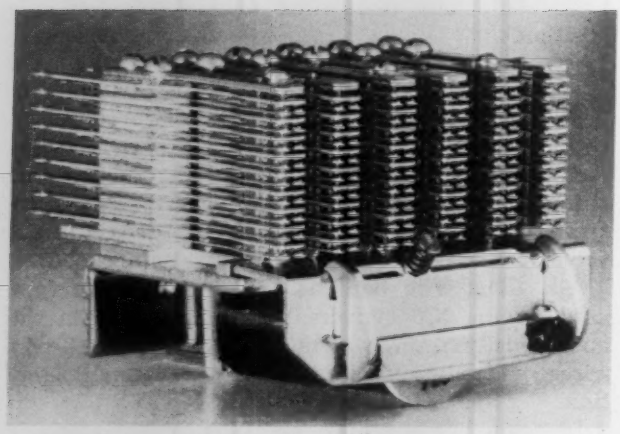

Fig. 9—Type *B* relay is assembled with three spring pile-ups from conventional type *A* relay. It can have a maximum of 60 make contacts.

current of the correct frequency is selected for application to the line. Other uses of the Deca switch are found in such applications as machine tool control systems, vending and record-playing machines, counting devices, and similar systems.

Telephone Type Relays

The relays used in modern telephone systems are the result of years of experience in the field of electromechanical switching. They were designed specifically for dial telephone systems, but because of their small size, operating characteristics, reliability, and long life, telephone type relays are particularly well adapted to the switching circuits now in use and presently being designed for automatic control systems.

Contacts for most applications in telephone systems are the twin dome type of silver or palladium. However, to meet special requirements other types may be specified. For handling heavy currents, contacts usually are the single button type made from silver or silver tungsten carbide. For very light current loads, contacts of gold alloy are preferred. Spring combinations used on telephone type relays include those shown in *Fig.* 6.

Coils on these relays are either single or double wound. The double wound coils can include one inductive and one non-inductive winding, two inductive windings with matched impedances, or two inductive windings with unmatched impedances.

The relay most commonly used in the *XY* dial system is the type *A* relay, *Fig.* 7; it is 4 inches long, 7/8-inches wide and 2 5/8 inches high with a maximum of 20 make contacts. It is the standard from which a wide variety of special application relays can be obtained. By adding a copper slug or sleeve to the coil assembly, slow operate, slow release or slow acting characteristics can be obtained. The addition of a nickel-silver sleeve over the coil core and special relay adjustments provide a relay which repeats pulses with a minimum amount of distortion. The addition of a lever to the assembly changes the ratio of contact travel to armature travel from 2.5:1 to 1:1 and thus changes the relay characteristics.

The above modifications are but a few of the many means by which the standard relay is altered to obtain certain characteristics for particular circuit applications. The switching circuits shown in *Figs.* 2, 3, and 4 illustrate the use of fast acting, pulse repeating, and slow release relays in controlling the XY Universal Switch. The typical ringing trip circuit shown in *Fig.* 8 illustrates the use of a slow operate relay with double wound coil and a preliminary contact to perform a specialized function. In this operation, *RD* relay is operated from a previous system function. When the *SW* relay operates, ringing current is sent out to the called station through the low resistance winding of the *RT* relay. During the ringing period, only the telephone ringer in series with the ringing capacitor is across the line. The design of the coil on the *RT* relay is such that the relay will not respond to alternating currents used for ringing. When the called subscriber answers, a resistance bridge (the transmitter) across the line causes direct current to flow. This direct current is of an order sufficient to operate the *RT* relay armature to a position which will close the preliminary make contact. The relay will then operate fully due to current through the secondary high resistance winding and actuate the remaining contacts which close the circuit between calling and called parties and also initiate other control and indication circuits.

It is obvious that the relatively large number of control and indication contacts which are re-

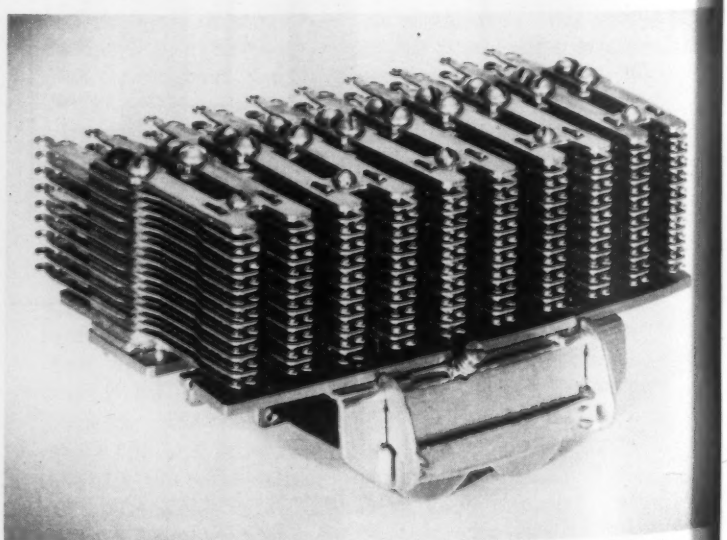

Fig. 10—Modified type *B* relay is designed for complex multiple switching systems such as in computer circuits. Unit can be equipped with a maximum of 100 make contacts.

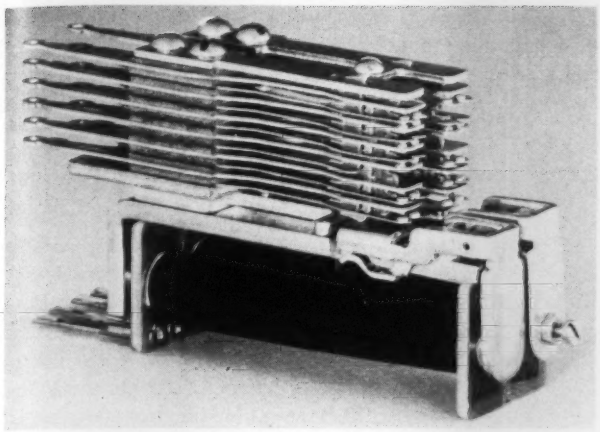

Fig. 11—Unit using same spring pile-up as *A* type contains two separate armatures and coils built on a common frame. Each armature can actuate up to ten make contacts (one side of the 20 available contacts in a double pile-up).

quired on the *RT* relay could not be actuated with the limited amount of current available when the called party answers unless control and slave relays are used. However, by using a relay with a double wound coil and a preliminary make contact, one unit serves as both slave and control.

Another relay which is used extensively in the automatic telephone field is the type *B* relay, *Fig.* 9. This unit is a gang type relay which is assembled with three spring pile-ups from the conventional type *A* relay. Consequently, the type *B* relay can have a maximum of 60 make contacts. On medium loads the relay is equipped with a single coil similar to that used on type *A* relays. On units approaching the maximum pile-ups and including large numbers of break and break-before-make contacts, two coils are used to provide the power required.

In order to meet the increasing demand for a gang type relay which can be used in computer circuits, tabulating devices and other complex multiple switching systems, the type *B* relay has been modified slightly to the type *BB*, *Fig.* 10. This type has five spring pile-ups and can be equipped with a maximum of 100 make contacts. A unit such as this naturally requires more power than the conventional type *B* relay and consequently utilizes two coils.

The third relay, type *C*, commonly used in automatic telephone systems has the same physical dimensions as the type *A* relay but the unit is, in effect, two relays in one, *Fig.* 11. The two sections utilize a common frame but have separate armatures and coils which operate independently. The spring pile-up is the same as that used on types *A* and *B* relays. Each of the two armatures operates one side of the double pile-up. Consequently, each armature can actuate up to 10 make contacts. The type *C* relay is normally used where space is an important factor, and where a large number of contacts is not required.

The *A*, *B*, and *C* type relays which have been briefly described are normally used in 24 and 48 volt telephone systems, and in some instances operate over long loops on currents as low as 3 milliamperes. With the advent of nationwide dialing and toll ticketing systems, and the increasing use of carrier and microwave systems, these relays are now being used in conjunction with electronic amplifiers to switch a large number of relatively high current circuits by a weak signal.

Individual Carriers Controlled In Versatile Finishing System

BYPASS MECHANISM which automatically controls as many as nine or more complete metal finishing processes on a single anodizing or electroplating machine is manufactured by Hanson-Van Winkle-Munning Co. The new mechanism is a part of the Dial-A-Cycle system for automatic metal finishing.

This system is controlled from a dial on the carrier arm that moves parts through processing tanks. As unfinished parts are loaded on the carrier, the machine operator sets the dial for the processing steps through which the load is to move. Automatic conveying does the rest, lowering parts into the prescribed tanks, bypassing others, according to the dial setting.

Heart of the system is a series of limit switches and solenoid-operated setdown flippers that control the action of the carrier. The Dial-A-Cycle control mechanism, located at the back of each carrier arm, is set after parts have been loaded at the machine's load-unload station. The operator rotates the dial to the setting prescribed for the raw parts just loaded. This moves a contact flag into one of several positions, in which it contacts or bypasses flippers and switches at each tank. No further manual operation is necessary until finished parts are unloaded. With bypass features of the system plus timing and process control features of the basic machine, an almost infinite combination of sequences and dwell periods for cleaning, rinsing, etching, anodizing, plating, coloring and sealing can be achieved.

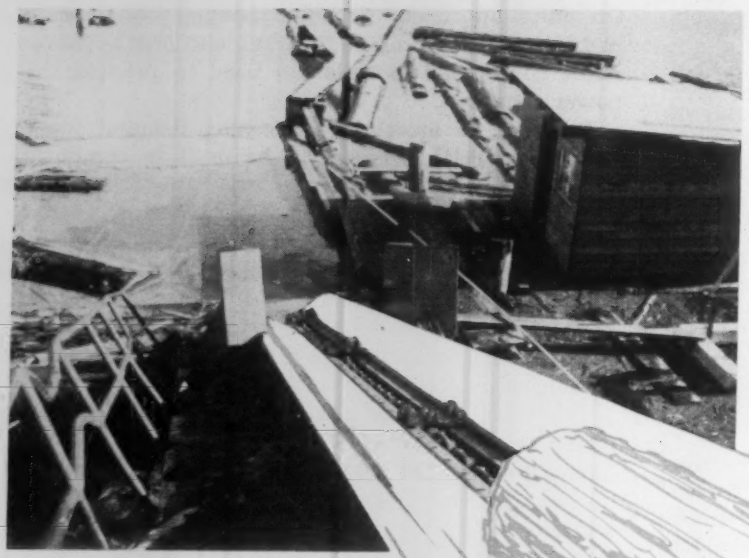

Fig. 1—Starting point for the trip through the sawmill is this log haul which carries logs from the storage pond up to the sawing area. An operator guides the desired logs into the bottom of the log haul, which is automatically controlled.

PHOTOELECTRIC CONTROL SYSTEM AUTOMATES LOG HANDLING

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Many operations in the lumber industry illustrate production problems typical of other industries where limited capital resources and multiplicity of raw material and product variations have tended to restrict the application of automation. The development of the automatic system described here has helped make possible a profitable sawmill operation cutting low quality salvage logs varying widely in shape and weight.

AUTOMATING OF SAWMILL operations is an engineering challenge which has only recently received serious consideration by the lumber industry. The complex variables of sawmilling procedure have discouraged attempts to apply automation processes which have proved so successful in other industries. Logs are the raw material of the sawmill, and in the mill described here, they may vary from 6 inches to 4 feet in diameter, from 6 feet to 20 feet in length, and from 200 pounds to 15,000 pounds in weight. The technique of sawing varies with the species of timber coming into the mill and the products required. Products cut from these logs may vary from 1-inch boards to 8 inch by 24 inch cants. Quality of boards cut in identical manner and to the same size may be affected by knots, defects in the tree, and other characteristics. As many as 10 or more grades of each size may be produced.

To further deter the application of automation principles, most sawmills are small, family-size businesses which lack the capital to invest in mechanical improvements. Of the larger sawmills,

few are actually large enough businesses to be able to plow adequate capital back into required machines for automation. Also, in these few large mills the engineers who might initiate automation processes have been few in number and small of voice.

However, segments of the sawmill industry are solving the problem of cost reduction and quality control through the use of automatic processes. The Hammond Lumber Co., a large lumber manufacturer with sawmills in the redwood region of California, is one of the forward looking lumber producers who have initiated a program of research and development toward automation in its sawmills. Their program is being carried on under the direction of an engineering consulting firm specializing in sawmill automation. Hammond's new efficient sawmill near Eureka, California, is being used as a testing laboratory for the development of improved processes. This mill is ideally suited for such a development since it cuts mostly a very poor grade of salvage log. To profitably cut good lumber out of poor quality logs, a very high degree of automatic processing is required. An extensive program of proposed improvements was initiated.

Operation Before Automation

At this sawmill, as at most mills in the Northwest, logs are stored in a log pond. The purpose of this water storage is twofold: It makes an inexpensive method of handling and sorting the variety of log shapes and weights, and it acts as a soaking pit for the logs, washing off dirt and loose bark. The first problem is to bring the logs from the storage pond into the sawmill to a log deck, ready to load onto the sawmill carriage. This carriage carries them to the saw which saws the logs into lumber.

An automatic log deck was the first of a series of proposed improvements. The principles applied in the automatic deck can be applied to the handling of other large, unwieldy materials. Under the old method of bringing logs from the log pond to the sawmill carriage, two men were required. One man on the mill pond guided a log into the log haul or log slip, *Fig.* 1. The log haul, an endless chain with toothed lugs every ten feet on which the logs ride, pulled them lengthwise into the mill to the log deck. A second man stopped the log haul chain, operated kickers that ejected the log sideways onto the log deck chains, restarted the log haul chain, started the deck chains, and stopped the deck chains when the log or logs were crowded against the log stop and loader mechanism for the sawmill carriage.

Automation of this log deck was especially difficult not only because of the variety of log sizes, but also due to the type of logs handled in this mill. They are not even as round as better quality logs usually are, and they include all manner of warped and misshapen forms. Some of the logs have large knots and growths so that they act

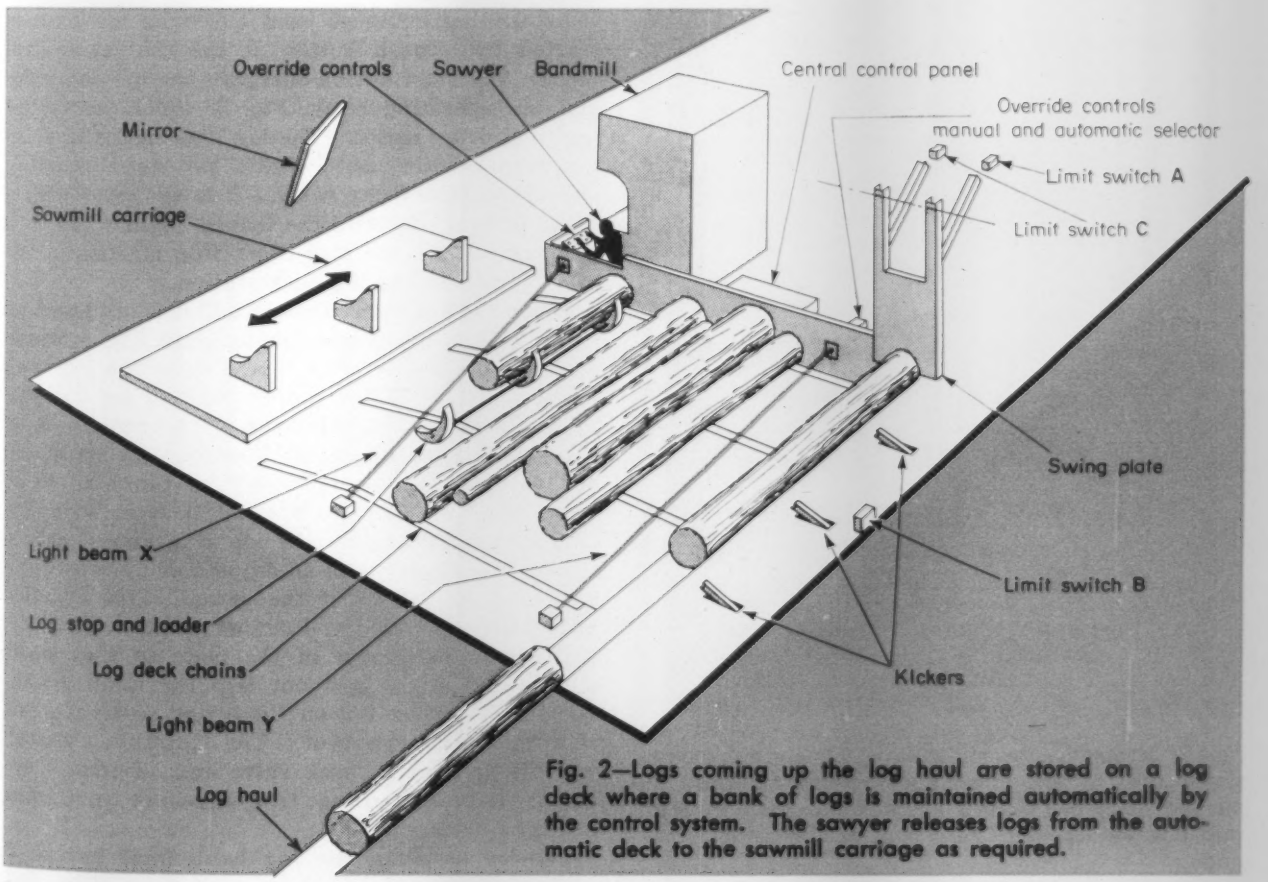


Fig. 2—Logs coming up the log haul are stored on a log deck where a bank of logs is maintained automatically by the control system. The sawyer releases logs from the automatic deck to the sawmill carriage as required.

like teeter-totters on the log haul, and some that were burned out in the center have split into unwieldy sections. Many of the logs handled in this mill would not be considered as usable logs in most sawmills. To further complicate the problem at this mill, the log haul is used to convey trash from the log pond. Large pieces of bark, chunks of wood, chips and sticks, are run up the log haul, over the end and into a waste conveyor.

The Automatic System

Despite these problems, a system to successfully automate the log deck and log haul has been in operation for many months, and the need for a second man has been eliminated. Layout of the automatic system for the log delivery operation is shown in *Fig.* 2.

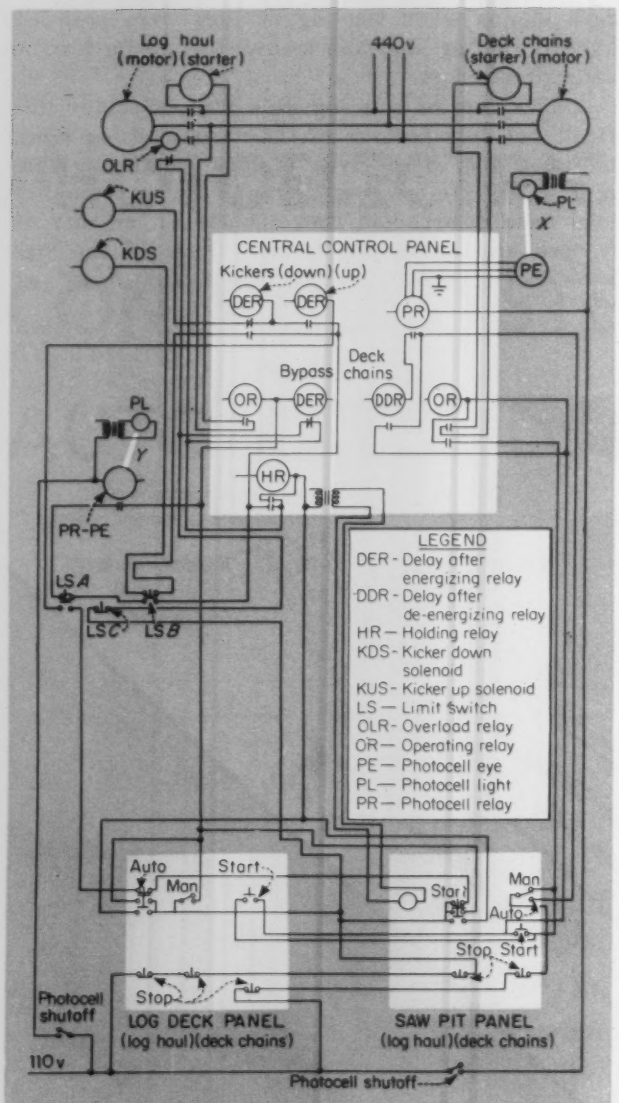


Fig. 3—Schematic diagram depicts the electric control system used to automatically co-ordinate operation of the log haul, the kickers, the log deck and the log stop and loader which feed logs to the sawmill carriage.

Fig. 4—Limit switches to stop the log haul so that a log can be kicked onto the log deck are tripped when the log strikes this swing plate. The hydraulic cylinder damps out swing of the plate and resists tripping of the plate by trash.

At the beginning of each shift the log haul is started by a push button at the central control panel. The start button energizes the holding relay and the operating relay, *Fig.* 3, which starts the log haul drive motor. The log haul motor is a 30-hp wound rotor motor with two-stage starting through a time delay relay. It is equipped with a solenoid brake to hold the loaded chain when it is stopped. There are also *Start-Stop* buttons in the saw pit and at the log deck station.

When the log enters the sawmill it is drawn along until it hits a heavy steel swing plate, *Fig.* 4, which trips limit switch *A*, *Fig.* 2, and stops the log haul, leaving the log in the proper position for delivery to the deck chains. Because of the roughness of the logs and the impact with which they strike the swing plate, it was necessary to fabricate it of heavy stock. Then, to prevent it from swinging like a pendulum after the log was kicked out, a hydraulic cylinder with an adjustable by-pass valve was used to damp out the swing. This cylinder also has a secondary function of providing resistance to movement of the plate so that small slivers and sticks will not trip the limit switch, but break themselves on the swing plate and fall into the waste conveyor. The hydraulic cylinder was fitted with a check valve and adjustable by-pass relief valve, so that trial-and-error corrections could be made initially.

Besides stopping the log haul, limit switch *A*

energizes a time delay relay that closes a circuit to a two-way solenoid valve after a delay which insures that the log haul has come to rest. The solenoid valve controls a Westinghouse air cylinder which pushes a lever to operate a Davies blocked center poppet valve which controls a large air cylinder. The large cylinder kicks the logs out of the delivery trough by means of mechanical linkages and heavy steel bars.

When the log is kicked out of the log haul, *Fig.* 5, the swing plate returns to its normal position; and this activates the log kicker valve, causing the log kickers to return to rest position. The return of the swing plate to normal also starts the log haul again, drawing up another log. Starting of the log haul is interlocked with the return of the log kickers to normal position through limit switch *B*.

Since safety is a prime consideration in modern sawmill operations, a safety limit switch *C* is mounted behind swing plate limit switch *A*. If limit switch *A* fails to operate, limit switch *C* will trip out the holding circuit on the log haul motor control. The motor then must be started manually, disclosing the failure of limit switch *A*. The sawyer, who controls the entire log deck and log carriage operation from his saw pit, is informed of the dropping out of the holding relay when a signal light in the saw pit goes out.

Transverse chains on the log deck deliver the logs from the log haul to the log stop and loader. This is a set of rocker arms which hold one log at a time; when the sawyer steps on a foot pedal an air cylinder rotates the rocker shaft, dumping the log toward the sawmill carriage and holding back the next log. When the sawyer releases the foot pedal, the air cylinder restores the stop and loader device to its initial position. The 4-way, spring return, foot operated valve in the saw pit controls a cylinder that operates a valve. This valve in turn controls a large cylinder in which there is always air pressure either to hold logs back or dump them forward, depending on the position of the pilot valve.

Control of Supply Bank

It is desirable to have six or eight logs on the deck chains at one time, so that if the pond man delays in sending logs to the log haul, the saw will not be idle. The bank of logs is controlled on this automatic deck by means of two photoelectric circuits, *Fig.* 2. Light beam *X* hits its photoelectric cell when the log stop and loader is empty after dumping a log from the log deck to the sawmill carriage. The cell energizes a relay that causes the deck chains to start moving toward the stop and loader. When the next log enters the stop and loader and interrupts light beam *X*, an after de-energizing time delay relay permits the deck chains to crowd the logs forward to the stop and loader. When the deck chains clear the last log from the path of light beam *Y*, the log haul circuit is cleared so that log delivery from the pond can continue until the deck is full. When the log deck is full, light beam *Y* is interrupted so that the log haul is stopped, delivering no more logs until the back space of the deck is cleared and there is room for another log. Clearing light beam *Y* automatically starts the cycle again.

Feasibility of automating a sawmill operation was under test in this installation. By incorporating safety devices, sequencing for fail safe operation, and proceeding in a step by step manner in automating the operation, the feasibility of at least partial automation in a sawmill was proved. Considerable effort was expended to make sure that the equipment and machinery used was operating trouble free prior to installation of the automatic controls, so that such defects as might be found in the automatic log haul could be directly traced to the automatic system. It was found that the automatic processes worked in a practical manner after the physical equipment was checked out. The success in automating the log deck has opened the door to the automation of many other sawmill operations. As the lumber industry sees the evidence of the value of automation we can expect a surge of interest in automatic processes for this industry.

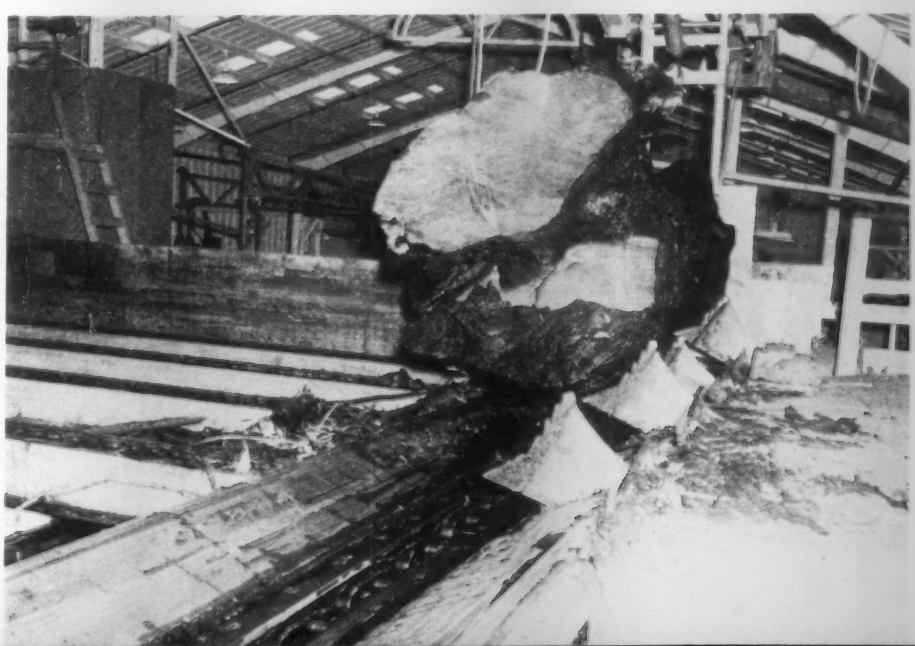


Fig. 5—This big redwood log being kicked out of the log haul trough illustrates the irregular forms which this automatic handling system must convey.

STANDARD GRINDER FITS AUTOMATED LINE

FORK TRUCK, automatic loading and gaging equipment, and a standard grinding machine combine to give high production rates on piston pins for 6 and 8-cylinder engines at the New Castle, Ind. plant of the Chrysler Corp. Operating cycle of this piston pin line begins when a fork truck lifts a hopper loaded with pins onto a rack, *Fig.* 1. Pins drop out of the hopper onto a belt conveyor which carries them up to a stacking drum that lines them up and feeds them down a channel to a standard double-spindle disk grinder built by Mattison Machine Works.

After the pins slide down the track they enter a magazine. They drop by gravity from the magazine into vee-blocks on a rotating fixture wheel that carries them between the grinding wheels. An equalizing device centers the pins to equalize the amount of stock removed from each end. A clamping chain holds the pins in position on the rotary fixture, *Fig.* 2, and before the pins are unclamped they pass between gaging units which contact each end of the pin. The sizing units are arranged so that when the pin length approaches the upper limit of the size setting, a feed mechanism is actuated on the spind'e slide to micro-feed the grinding heads, either jointly or independently, to compensate for wheel wear.

The ends of 32,000 pins can be ground in a 24-hour day if required. Both ends of each pin are ground, the pins being 0.859-inch diameter by 2.75 inches long for 6-cylinder engines, and 0.984-inch diameter by 3.00 inches long for 8-cylinder engines. Length tolerances are held to 0.004 inch with a 20 microinch finish.

After release from the rotary fixture the pins drop into another hopper. This hopper feeds a conveyor which transfers the pins to a loading device that carries them into a centerless grinder for finishing of the outside diameter.

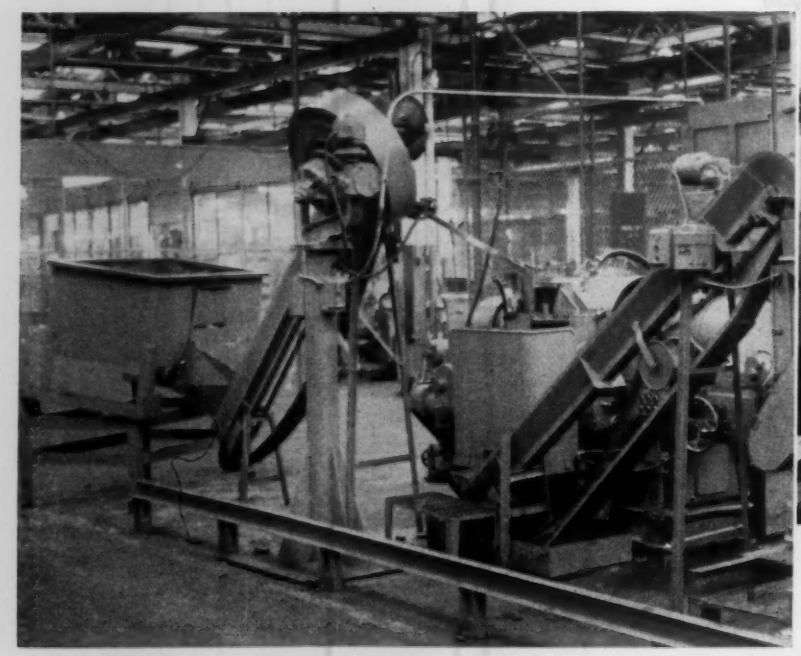


Fig. 1—Piston pins feed from hopper, positioned by fork truck, into standard 2-spindle grinder which simultaneously grinds both ends of each pin. Pins travel up second belt conveyor into centerless grinder for finishing of O.D.

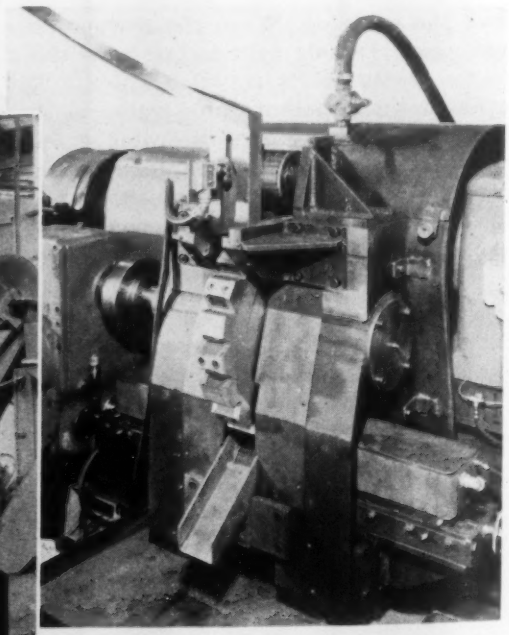
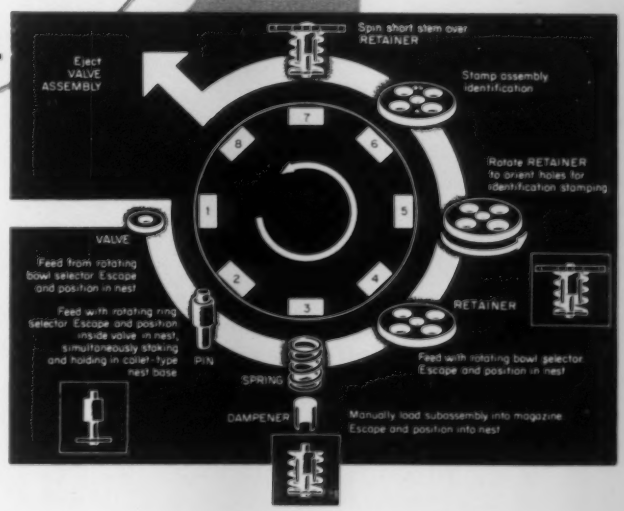


Fig. 2—Photo of disk grinder during construction shows magazine feeding rotary vee-block fixture and the chain which clamps the parts in position. Horizontal boxes near discharge chute at each side of the fixture wheel are the gaging units which control automatic wheel adjustments.

AUTOMATED ASSEMBLY—2

- TRANSFER
- FASTEN
- SENSE
- EJECT
- CONTROL



By **KENNETH R. TREER,** Gray Equipment Co., Cleveland, O.

Present assembly costs are the "sore thumbs" on the manufacturing cost distribution sheets. A new type of machine builder is required—and is evolving—to take the skills of many fields and combine them into assembly equipment.

GENERAL CONSIDERATIONS for the successful automation of assembly operations were discussed in part 1 of this article and the six elements of automatic assembly equipment were outlined in TABLE 1. The first element—parts feeding—was discussed and illustrated. Usually the next element of concern after parts feeding is that of transfer.

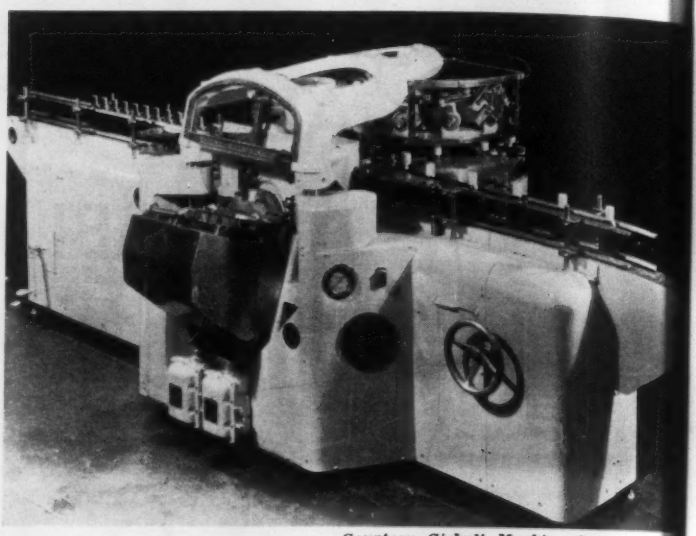
Transfer

As the term is used here, transfer means to move the part from one operating station to another or, conceivably, moving the operating stations from one part to another. Hence, single station automated machines require no transferring, merely loading and unloading. When more than one station is required any of several methods may be employed.

First consideration should be whether the machine will be continuous or cyclic. The application of printing, decals and roll marking can be continuous since the part does not need to stop under the marking device. Constantly moving conveyors or fixtures can pass parts through such processes at very high speeds with great accuracy. Equipment is usually custom designed and is not too common in assembly work other than seam welding, application of adhesives, etc.

Cyclic machines are usually necessary in assembly processes because of the cost of adapting presses, riveters, screwdrivers, nut runners, and similar equipment, to a moving workpiece. Two types of transfer devices may be used in cyclic equipment. The part alone may be transferred by picking it up with fingers, etc. and moving it from station to station as is now being featured in many transfer punch presses, or an entire fixture and part may be transported from station to station. The

Fig. 8—Various basic types of transfer positioning devices used to satisfy different requirements of workpiece motion for automated assembly equipment.



Courtesy Gisholt Machine Co.

Continuous assembly illustrated by machine that applies neck band seals to bottles. Conveyorized bottles pass under rotating turret of assembly heads without stopping. Principle provides high production rate with minimum setup time at changeover.

former method requires special design and is relatively inflexible, while the latter design is more easily converted if the product is changed and offers the use of many standard components of machines.

Moving fixture transfer machines are of three general types. The single fixture, which slides between two stations, is relatively common. Also in general use are the dial index tables which may have three or more stations angularly located on the face of the dial. Dials are made in a multitude of designs and accuracies. The lowest cost units consist of air cylinders which rotate the table with a ratchet mechanism. Other dials use the Geneva motion. Index must be smooth so that light parts may lie on top of an assembly without being disturbed by motion. Accuracies of 0.0005-inch in positioning may be obtained. Barrel cam indexers are now available with like accuracy permitting continuous indexing at high speeds with a smoothness of index comparable to the Geneva motions. The third type includes the in-line indexing machines, or transfer machines which carry any number of fixtures around a table or over and under a table. These are usually driven by barrel cams although they may be indexed with air or hydraulic cylinders, electric motors, etc.

Selection of the proper transfer equipment depends upon the type of assembly to be performed, number of stations required, accuracy of location required, economics of the process, quantity of assemblies per hour, and many other factors which must be applied individually to each case. *Fig.* 8 illustrates the various general types of transfer positioning devices.

In the case of the valve assembly in *Fig.* 1 (See AUTOMATION, Oct. 1956) the following factors caused the selection of a Geneva motion eight station dial index transfer machine:

1. Part size and shape not adaptable to moving the work pieces alone without being confined in a fixture or work nest.

2. Production rate of 2000 per hour would not justify a continuous motion machine.

3. Extremely wide variety of coil springs is used requiring frequent changeover from one spring compression to another. In some cases as few as 400 pieces, or 12 minutes running time are required from one spring size.

4. Eight stations satisfy the assembly requirements. It is considered that the low cost of dial index equipment for use up to 15 to 20 stations overrules the use of in-line indexers. In addition to the change of spring sizes, the entire fixture must be replaced for a second valve size which suggests keeping to a minimum the number of stations to be changed over.

5. Positioning accuracies of 0.001-inch or closer are required to facilitate consistent assembly of the pin to the valve and retainer.

6. A smooth index is definitely required to prevent dislocating the retainer after orientation and before marking.

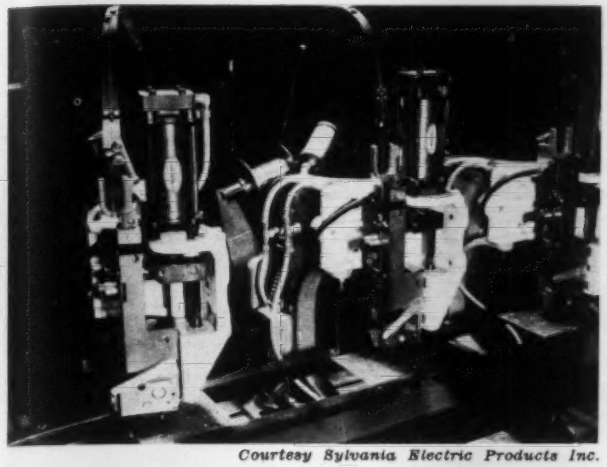
Fasten

The type of fastening which offers the highest product quality at the lowest unit cost with the least assembly and maintenance problems is, of course, the ideal method to use. Product design again should be carefully examined before committing an automation program to one definite method. A few types of fastening arrangements follow:

1. *Coining* permits assembling two or more parts without individual fasteners, usually involving forming an external or internal cup, shell or pin under impact or pressure to make a permanent fastening. The valve in *Fig.* 1 is later assembled into a body whose open end is coined inward to secure the valve permanently without damaging any parts of the assembly.

2. *Staking* is the deforming of a pin or projection, usually part of one of the assembly pieces although a separate rivet or stud may be staked. The deforming consists of displacing some to the fastener material in such a manner as to prevent the assembled parts from separating.

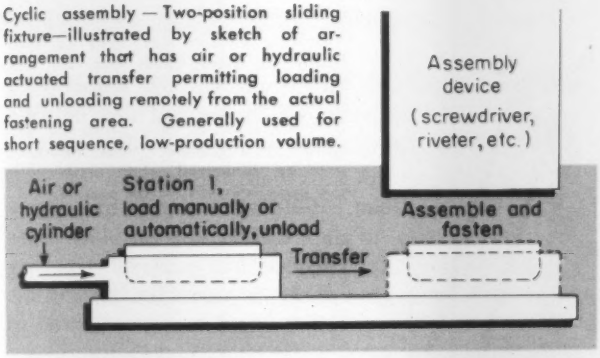
3. *Riveting* may conceivably be divided into a number of methods. Solid rivets may be coined over or staked. They may also be hammered on a rotary vibratory riveter to pack the metal tightly



Courtesy Sylvania Electric Products Inc.

Cyclic assembly—transferring workpiece without fixture—illustrated by machine that cuts off and inserts jumper wires into printed circuit boards. Mechanism simultaneously moves each part to the next work station. Primarily used where part size, configuration, or accuracy do not permit or do not require fixtures.

Cyclic assembly — Two-position sliding fixture—illustrated by sketch of arrangement that has air or hydraulic actuated transfer permitting loading and unloading remotely from the actual fastening area. Generally used for short sequence, low-production volume.


Assembly device (screwdriver, riveter, etc.)
Air or hydraulic cylinder
Station 1, load manually or automatically, unload
Transfer
Assemble and fasten

into its hole or serrations and provide a very tight fit by distorting the rivet stem. Noiseless rivet spinning machines permit the working of the rivet into a smooth head of excellent appearance with no appreciable distortion of the stem. This method is used when the rivet must act as a pivot or when the stem diameter must be held within tenths. Tubular rivets may be applied and coined at very high speeds. Eyelets, a form of rivet, with less holding strength are also coined at high speeds. Any of these riveting methods may be performed in multiples simultaneously with automatically fed rivets.

4. *Spinning* may be used to close over a cup-shaped part, curl an edge or draw materials which are ductile into circular forms. Very tight seals on brittle materials and delicate parts such as fabric diaphragms may safely be made with spinning.

5. *Screwdriving* is commonly used for automatic fastening. Hopper-fed power screwdrivers are available in one or more spindles and are being attached to transfer machines in complex combinations. A high uniformity and quality of screws must be used to prevent feeder jamming and the type of screw head has an important relationship to the possible torque which may be applied. Self-tapping and thread-cutting screws may be used with certain head types.

6. *Stud-setting* where the stud itself cuts the threads in diecastings, for example, may be performed in multiples at high speeds eliminating the tapping operations.

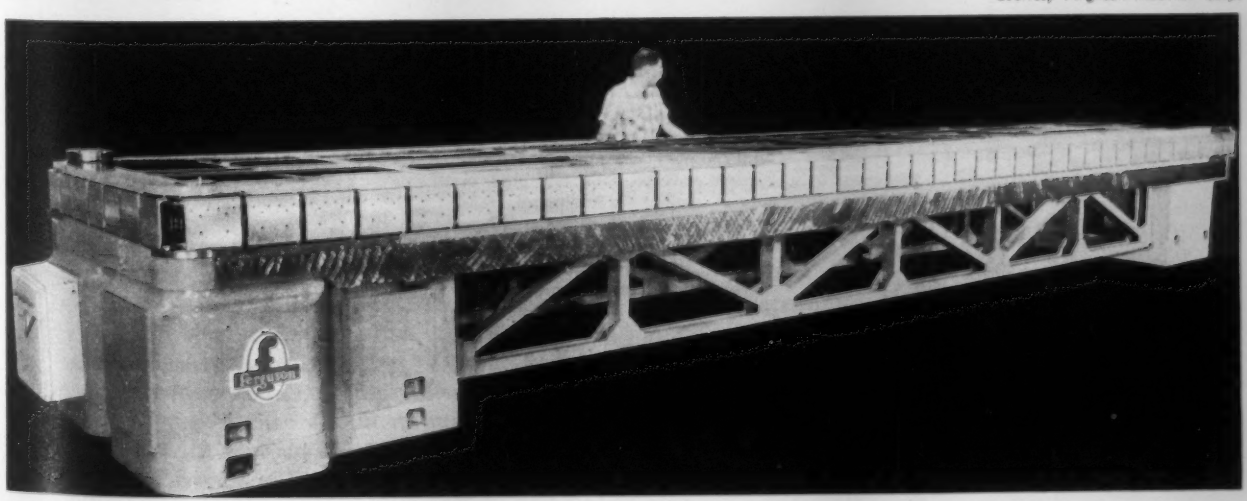
7. *Nut-setting* machines are available in hopper-

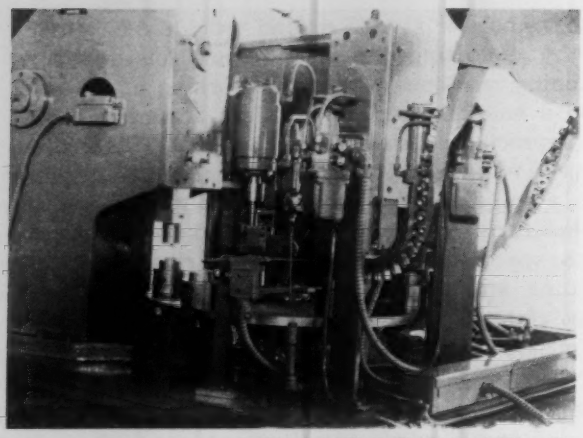
Courtesy Gray Equipment Mfg. Co.

Cyclic assembly—dial index—best suited for 4 to 12 station operation with work nests mounted on table. Illustrated is a Geneva motion, air-operated dial with positional accuracy held by a positive acting shot bolt. Ratchet type air-cylinder tables and barrel cam tables offer similar accuracies, indexing in one to one-tenth second.

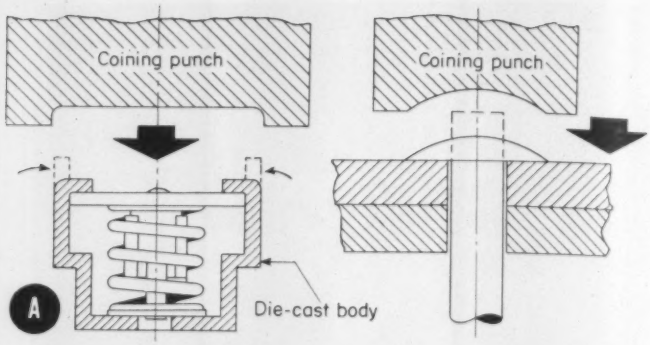
Cyclic assembly—in-line index—fixture stations move intermittently around perimeter of table. Permits large number of work stations in long operational sequence. Indexing time varies with distance to be moved and weight of parts.

Courtesy Ferguson Machine Corp.

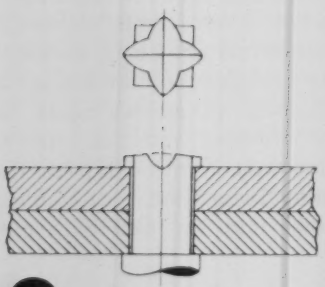




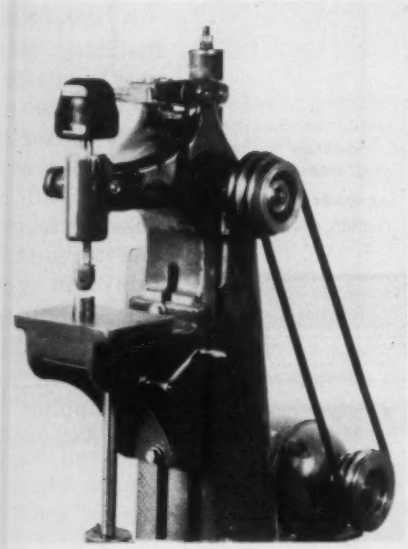
Courtesy Gray Equipment Mfg. Co.



Air toggle press head at left of photo coins die cast body over valve assembly. Coining may also be used to form a flange on a tubular core to hold parts on the outside. Sketch shows coining punch forming a rivet head. All of these steps may be performed in multiples on standard equipment.

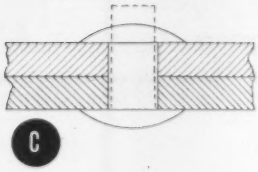


While coining forms a part, staking usually deforms by displacing sufficient metal to prevent assemblies from coming apart. Two parts sketched are kept from turning by a square rivet which is staked to hold it in place.



Courtesy Grant Mfg. and Machine Co.

Vibratory riveters are used to form heads on rivets which must be very tight in assembly. The hammer action is designed to deform the rivet stem, in many cases actually filling out serrations in the holes. This deforming may be minimized when undesirable, but some will always be present.



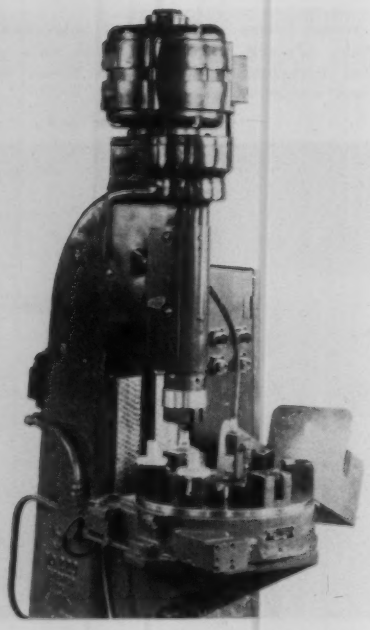
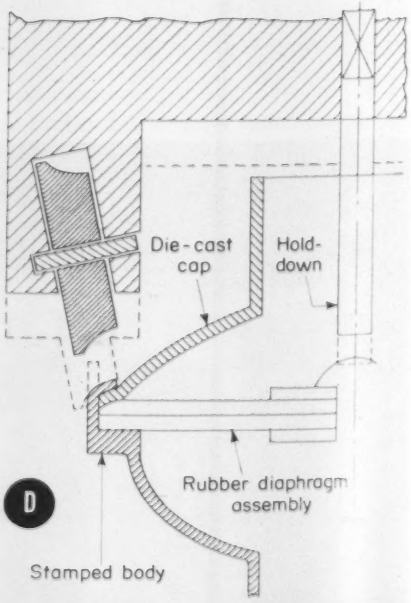
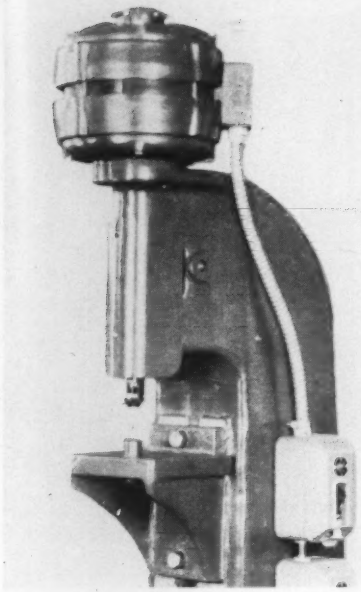


Photo shows dial assembly spinner for manual loading and automatic ejection of top, bottom and diaphragm assembly of automative vacuum cup. Spun seal must be air tight without cutting rubber diaphragm. Three rolls are used in special holder. Additional rolls might be used of different shape to provide "progressive" spinning of cup. Hold-down through center of roll holder provides proper diaphragm slack as it is assembled.

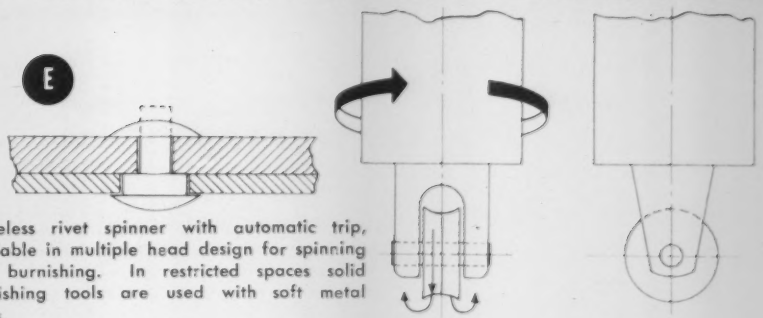


Courtesy Grant Mfg. and Machine Co.



Courtesy Grant Mfg. and Machine Co.

Fig. 9—Parts that have been assembled may be fastened together by any of a vast array of techniques. Fastenings used offer opportunities for co-ordination of product design and manufacturing process that accomplishes savings. Standard equipment to perform these operations is attached to the assembly machine.



Noiseless rivet spinner with automatic trip, available in multiple head design for spinning and burnishing. In restricted spaces solid burnishing tools are used with soft metal rivets.

Roll-holder rotates about rivet stem axis. Rolls turn in opposite directions rolling rivet stem into a head. Head shapes may be flat, conical or have a radius.

Pivot point formed with shouldered rivet. Light spinning pressure required causes no measurable deforming of stem.

fed models for automatically feeding and driving nuts to precise torque requirements.

8. *Welding* equipment is available in many types for the automatic fastening of assemblies. Spot welding in one or multiples of spots simultaneously, seam welding for continuous or cyclic operations, gas and electric arc welding all can be adapted. Automatic soldering devices may also be attached to assembly machines.

9. *Special fasteners* from wire forms and sheet metal clips to adhesives are also used. In general, special fasteners require special feeding and application equipment, and their use should be carefully examined in the light of equipment availability and operating costs.

Whatever fastening method is used, it should be automatic. Usually it will involve a separate machine in its own right which is mounted adjacent to or on the transfer device. It should be synchronized to the transfer machine and interlocked with it to prevent damage to part, machine or tooling. The fastening equipment should be selected for maximum tool life and minimum downtime.

Standard equipment is available for all of the above methods which can readily be attached to your transfer equipment. Typical examples are illustrated in *Fig.* 9 together with sketches of their types of fastenings.

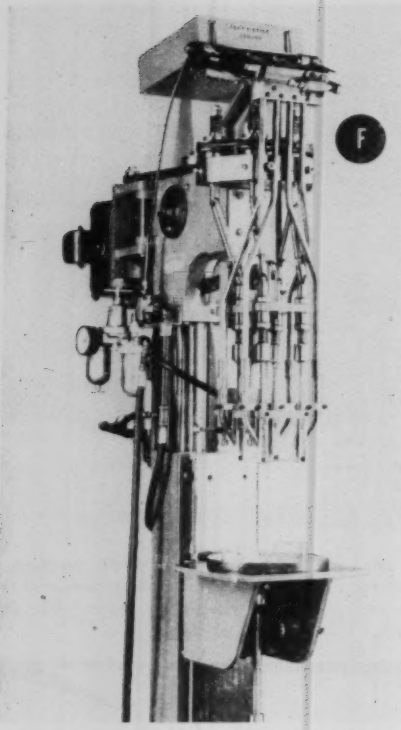
The valve assembly in *Fig.* 1 uses two types of fastenings. The long end of the pin must be a free fit on the valve and yet prevent its coming off. The free fit suggests spinning the valve end, but the space limitations allowed no room for spinner heads. Since there was plenty of stem length beyond the necessary amount for valve movement, this end was cross-staked simultaneously with the pin assembly with the valve. In addition, a hole in the fixture directly above the staking tool acted as a collet to hold the pin after staking expanded the pin. Three functions were thus performed in one action—assembly, staking and collet holding. The short end of the pin had to be assembled tightly with the retainer to prevent rotation of the pin in its end use. Here staking seems indicated, but the long stem which must take any staking or coining force would be subject to bending and deforming, so a spinner head was used to supply a very neat, snug fastening without distortion of the pin. Further, this is the end of the valve assembly which must slide smoothly in a subsequent parts-feeder and the spun rivet is much smoother than a staked end.

▶ Sense and/or Sort

Just as the feed, transfer, fasten and eject elements replace human hands and feet, the sense and sort elements replace human senses of sight, touch, sound, smell and taste. These elements and the control element provide the automation touch to mechanization.

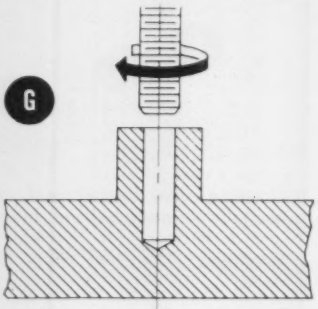
All manner of devices are available to substitute for the five human senses. The most commonly used are for the touch sense, with sight and sound devices close behind. A very few applications are illustrated in *Fig.* 10.

A quantitative touch sense is provided by probes. These are used to prevent scrap, tool damage, machines running "dry", or similar complications, by merely determining whether parts are properly in place, assembled, ejected, etc. Probes are usually added to machines to stop them when improper conditions occur or to start them when proper conditions exist. Their nerves and muscles may be mechanical, electrical, electronic, hydraulic or pneumatic. The customary probe actuates one or

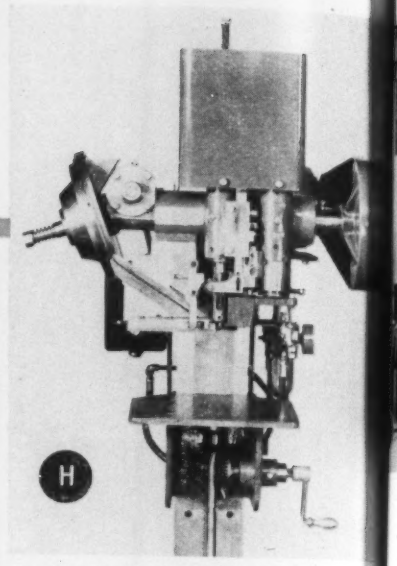


Courtesy Cook and Chick Co.

Four-spindle, hopper-fed, power screwdriver setup for feeding and driving screws simultaneously. Consistent hole spacing, part location and uniformity of screws are important to satisfactory operation of multispindle screwdrivers. Most screw head types may be driven satisfactorily within close limits of torque. Hardened thread-forming screws require maximum wrench contact, such as hex head screws, for consistent results.



Stud-setting permits assembly with other parts without tapping or loose screws. Machines are in use for setting 1 to 10 studs in die castings and similar materials. Standard stud setting tools may be adapted for automatic feeding of studs and multiple installations.



Courtesy Cook and Chick Co.

Standard single-spindle, air-operated, hopper-fed automatic nut runner.

more limit switches or valves to tell of one or more existing conditions which actuate or interrupt machine operation through relays in the control box or pistons in a fluid circuit. The cost of probes is not high, but their malfunctions can be very troublesome. Probes may be optical, chemical or audio as well as mechanical.

The qualitative sense is supplied by gages of all types for measuring size, weight, pressure, resistance, color, surface finish, etc. They may be used for sorting assemblies into acceptable and rejected parts bins, segregating into classifications, marking, color coding and otherwise identifying. They may also be used for the sensing elements in a feedback system which alters the operation of the machine as discussed later.

Counters are a definite part of every automated device, preferably indicating the quantity of acceptable assemblies produced. They may, however, be used for recording additional information in many ways.

The valve assembly machine in *Fig.* 1 has probes which are integral with the positioning devices to stop the machine and turn on a red light to warn the operator whenever any one of the following conditions occurs: (1) No pin is fed or pin does not seat, (2) no valve is fed or valve does not seat, (3) no retainer is fed or retainer is not down, (4) assembly is not ejected.

Due to the nature of parts-feeders, in which malfunctions must be corrected manually, lack of these probes could result in the making of considerable scrap before discovery. It would be practical to inspect these valves for spring pressure if so desired on the machine. All springs are tested prior to assembly, however, and this feature is not required.

In the assembly machine that is used following the machine illustrated in *Fig.* 1, a body is fed to a nest, a punching operation performed on it, the valve assembly inserted and the whole assembly coined over, *Fig.* 9. In this machine, failure to feed a body does not stop the machine but no valve is fed to an empty nest. This machine can cycle empty under these conditions.

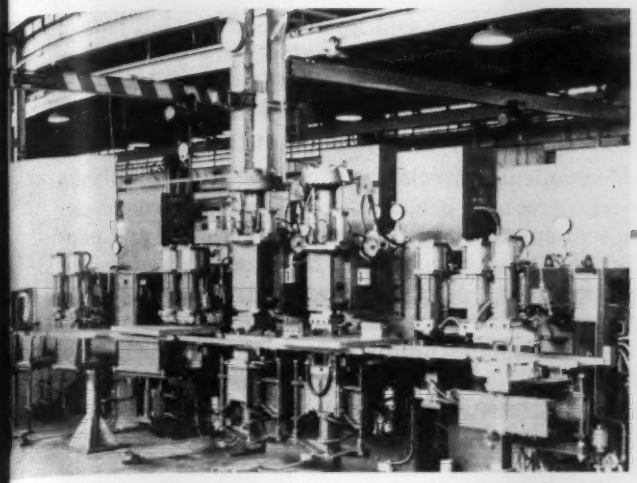
▶ Eject

Ejection methods fall into one of three general groups. Random, controlled or oriented ejection may be used. Random ejection is probably the most common method and is performed in an infinite number of ways including blow-off devices using compressed air, wipe-off devices using simple cams, dropping the assembly out of the bottom of the fixture, removal with fingers, etc. Parts ejected in this manner are usually dropped into tubes or onto conveyors or directly into pans or other material handling devices.

Controlled ejection may be desirable when bulk packaging, continuous marking, or similar operations follow. The term controlled ejection would apply when total specific orientation is not required.

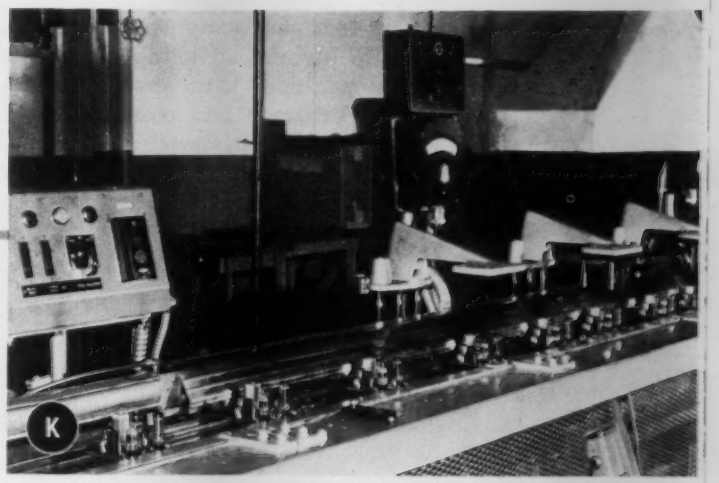
When subsequent operations can be synchronized, it is sometimes desirable to eject an assembly in an oriented position into tracks, tubes or conveyors to be transported. In this event the possibilities of each assembly size and shape must be individually examined. A few ejection methods are illustrated in *Fig.* 11.

Referring back to the valve assembly machine in *Fig.* 1, as has been noted the next operation con-



Courtesy Sciaky Bros. Inc.

Welding is commonly used assembly fastener method. Spot and seam welding can be accomplished automatically by various electric or gas techniques. Resistance welding line shown combines standard machine types to fabricate air conditioner chassis.



Courtesy Sylvania Electric Products Inc.

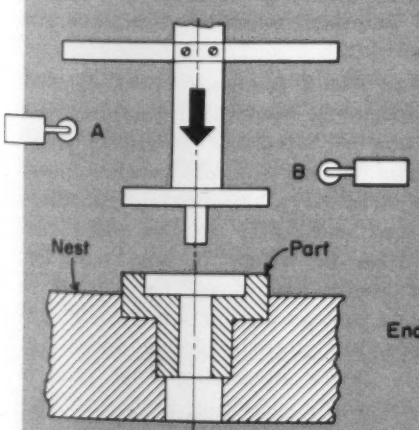
Soldering machine for completed radio chassis assemblies is a station in an automated assembly line.

sists of assembling a valve with a body on another machine. Automatically feeding and orienting the assembled valve at the next operation is relatively simple and inexpensive while an oriented transfer of the valve assemblies could be expensive. More important, however, is the wide variety of valve spring combinations and the extremely short lots (as low as 400 pieces) which are frequently run. To tie together these operations would seriously reduce the flexibility of the equipment. Hence, the machine was equipped with the ejection device sketched in *Fig.* 11, which involves pushing the assembly up above the top of the nest and blowing it into a tube with a quick air blast. The tube leads to a tote-pan in which these parts are normally handled.

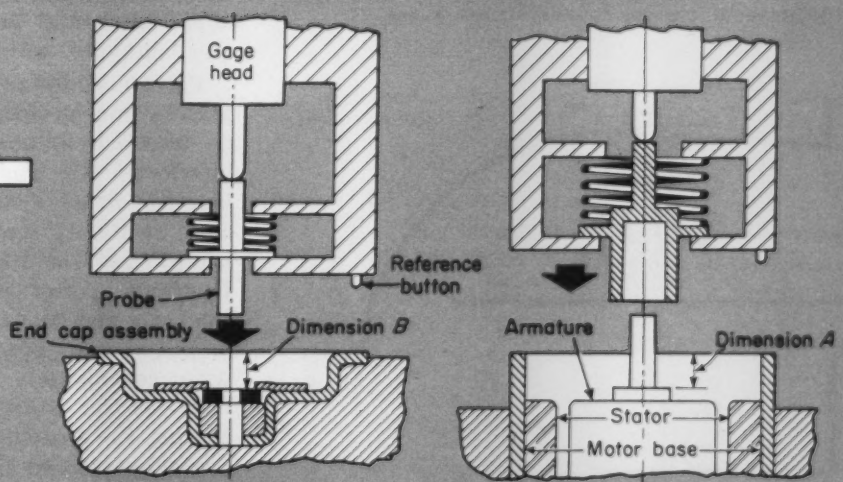
▸ Control

Here is the heart of automation. There are many, many methods of control. It is enough here to point out that there are mechanical, electrical, electronic, pneumatic and hydraulic systems for both motor power and control purposes. There

Fig. 10—Probes and gages are used to determine that things are as they should be, or to determine the state of things so that alternative actions can be initiated.



Probe station. Limit switch or valve A must operate to indicate part is seated in nest and that part has a hole through center. Actuation of switch or valve B indicates no part in nest. Switches or valves may actuate corrective devices, stop machine or cancel operation of subsequent station without stopping machine.



Gage heads for selecting proper quantity of shims to attain proper amount of motor shaft end play in assembly of electric motor armature and case with end cap. Two self-referencing gages, each measuring a variable dimension, (A and B), supply two dimensions for comparison electronically. Resulting signal is supplied on one of 6 circuits for the selection of one of 4 shims, no shim or to reject the assembly as unsatisfactory. Shims are positioned at subsequent station and gaging of next pair of parts delayed until shims are inserted.

is no "one best system" as many engineers feel. Each method has its distinct advantages and disadvantages, and an open mind is an absolute necessity if optimum performance and cost are to be obtained for each job. Most modern complex machines will utilize three or more of these methods in combination for the optimum result.

Whatever method or combination of methods is finally chosen, it should be designed to "fail safe"; that is, when it breaks down, wears out, shorts out or springs a leak, the machine should stop of its own accord and signal the operator rather than break up tools or assemble quantities of scrap.

Mechanical controls are preferred in many plants where personnel are best versed in mechanical devices and, of course, mechanical failures are usually readily visible in the form of broken parts, misalignment, etc. Electrical and electronic controls, where a plant has personnel who understand and can maintain them, are frequently best for lighter work and higher speed functioning. Pneumatic controls are quite common since most plants have air facilities. The controls are relatively inexpensive and fast in operation. Hydraulic controls are somewhat more expensive but are capable of handling heavier jobs with less maintenance and operating cost if the controls are not too complex. To combine the advantages and minimize the disadvantages of these various systems calls for engineering planning and familiarity with the features of all of them—a rare commodity.

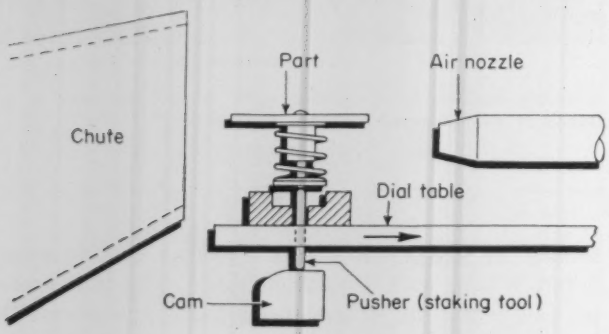
Feedback is a term which means self-correcting or self-checking. Just as the human eyes feed back intelligence as to where the hand is moving so the motor nerves of the brain can correct the motion of the hand, so can an assembly machine be equipped with sensing devices to determine what the machine is doing, to feed the information back to the control center where it is compared with what the machine should be doing, and to send an impulse to the proper unit to adjust it to its proper condition.

Interlocks, one of the signs of the professionally designed machine, are merely devices which prevent a unit operating or cause it to operate under a given set of sensed conditions. Electrical and electronic relays, hydraulic and pneumatic valves and mechanical arms perform these functions. Usually interlocks are added to the machine after the primary machine functions are laid out.

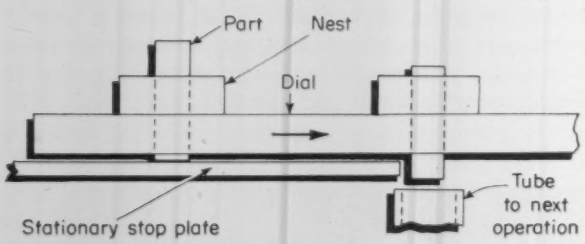
Valve machine in *Fig.* 1 is an air operated, electrically and mechanically controlled machine with no feedback system required but including many interlocks. Air was chosen for the motive power because of its availability, low initial equipment cost, flexibility and suitability to the plant personnel and facilities in which it was installed. Hydraulic power could have been used to drive the table and heads just as well at somewhat higher initial cost, possibly slightly slower speed, but with considerably lower operating cost. Air is used for the escapements, marking device and actuating the fastening units since it was felt to be somewhat faster than hydraulic means and less complex in the control system. Electrical escapements and marking devices could have been used.

Having completed this listing of the elements of automatic assembly equipment, the final part of the article, which will appear in next month's issue of AUTOMATION, will give a recommended procedure for automated assembly projects.

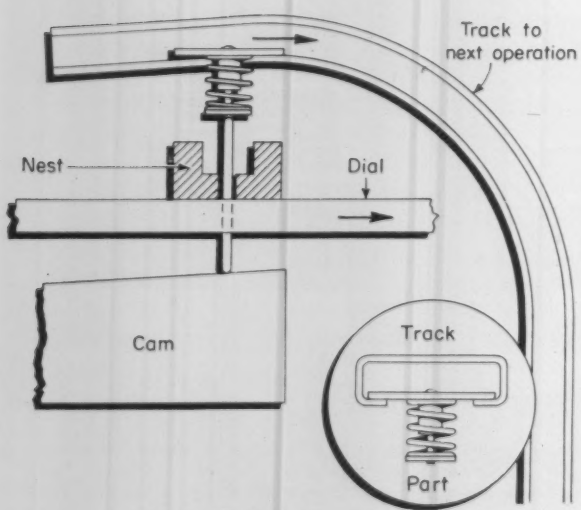
Fig. 11—Ejection of the completed workpiece may be in a random fashion or may be controlled to maintain previously established orientation.



Random ejection of valve in *Fig.* 1 is accomplished by camming the entire staking tool up through the bottom of the nest until the part is clear of the nest. Air blast blows the assembled parts into a chute which delivers parts to containers for delivery to next operation.



Controlled ejection of a cylindrical part can be accomplished in the case shown by dropping the assembly into a tube.



Oriented transfer of the assembled valve in *Fig.* 1 could have been accomplished by camming the assembly up into a track as the table indexed. Each assembly added to track would advance previous ones toward the positioning device on the next operation.

CONTROLLING POSITIONING MOTORS

To acquaint system planners and interested management readers with various applications possible with magnetic amplifiers and the respective advantages to be gained by their use, AUTOMATION presents a series of six application notes of which Controlling Positioning Motors is the first. Subsequent issues will describe motor speed control, switching functions, timing functions, process control, and voltage regulation applications.

By JAMES R. WALKER
Director of Research
Gemco Electric Co.
Detroit, Mich.

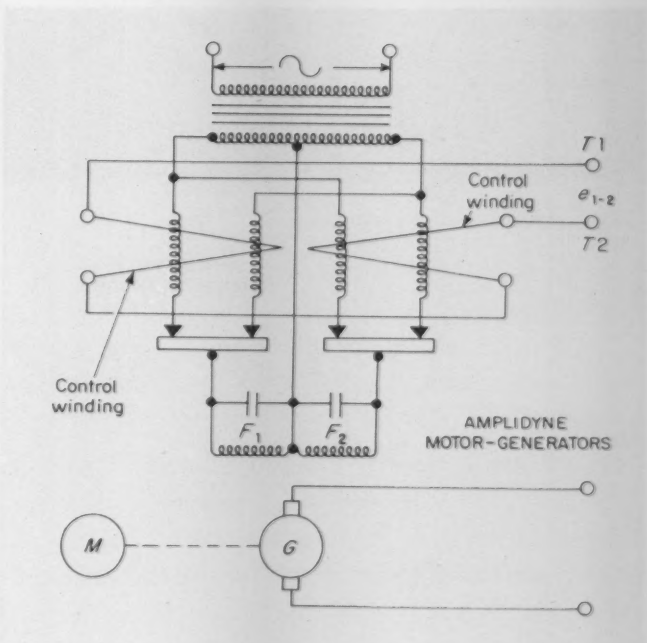
PRESENT APPLICATIONS of the magnetic amplifier, a specialized development of the saturable core reactor, are based upon characteristics whose potential usefulness has been recognized for a considerable number of years. The expanding industrial exploitation of the device, which can be considered in a general sense as competing with vacuum tube amplifiers in use, has been accelerated by increased interest in more reliable systems and by technological developments in electronics and metallurgy.

Servomechanisms utilized for positioning machine members in accordance with various command variables have been designed to employ vacuum tube amplifiers for achievement of necessary command signal amplification. Although an acceptable service period is obtained from equipment employing vacuum tube amplifiers it is nevertheless true that failure of the servosystem is invariably attributed to vacuum tube failure, whether or not this is an actuality.

Much attention has therefore been given to the possible replacement of vacuum tube amplifiers with magnetic amplifiers—which have earned for themselves the reputation of satisfactory electrical response for most applications without the attendant short life experienced with vacuum tube amplifiers.

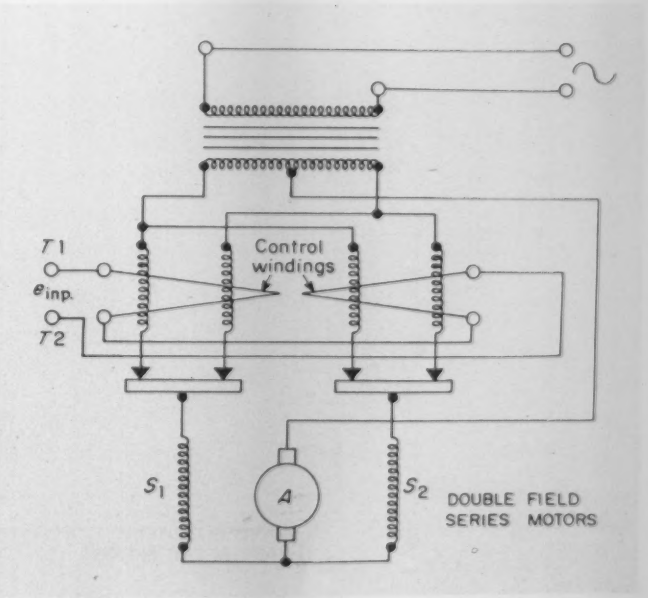
Amplidyne Motor-Generators

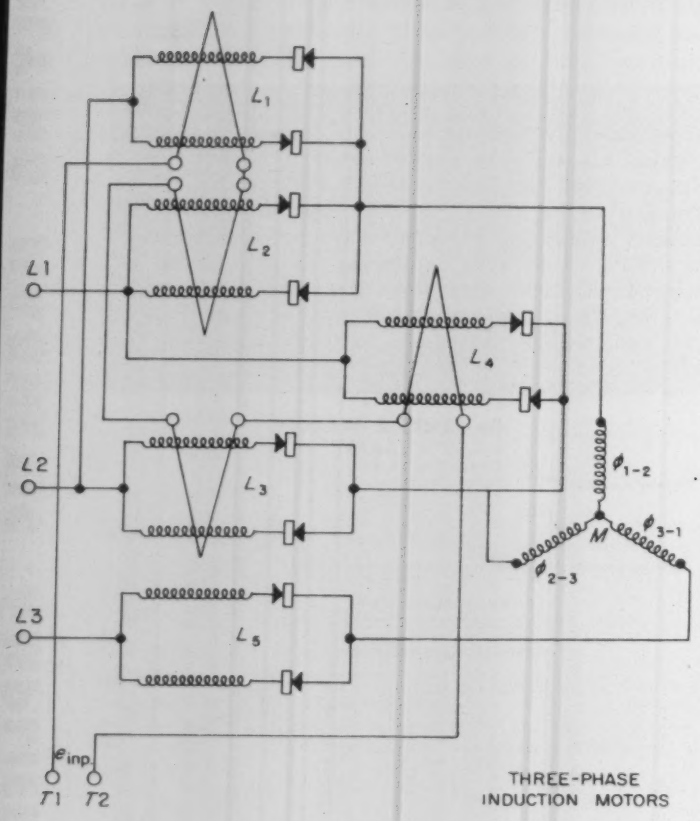
In this amplidyne generator control circuit it may be noted that a push-pull type (center tap connected) magnetic amplifier similar to that shown for the double-field series motor is used to excite the control fields in accordance with polarity of command input signal $e_{1\text{-}2}$. Such a system is limited in bandwidth or response principally by the amplidyne generator and motor combination itself and has been used for machine tool positioning systems, valve controls and a great number of military applications.



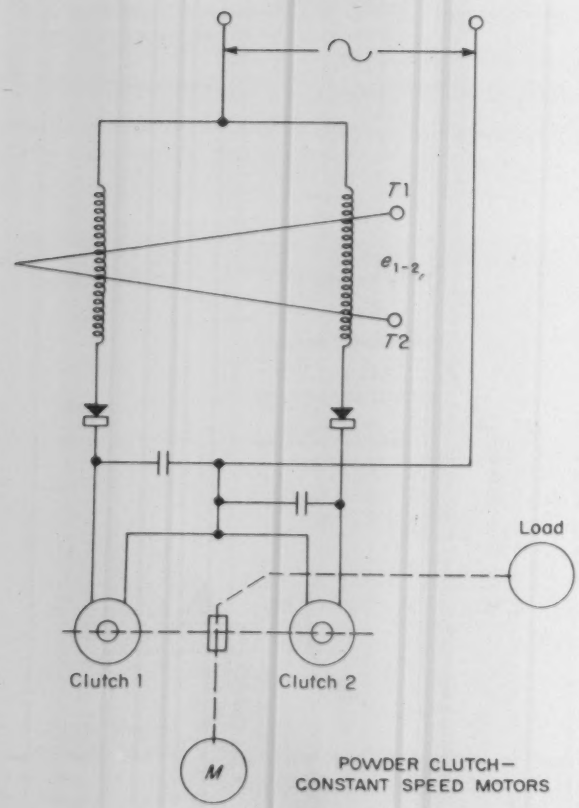
Double Field Series Motors

Function of the control circuit for a double-field series motor follows from the initial assumption if there is no signal input ($e_{1\text{-}2} = 0$) equal excitation current is supplied to both of the motor series fields S_1 and S_2, and no rotation of armature A occurs. However, if the command signal polarity is such that terminal $T1$ is positive with respect to terminal $T2$, then





THREE-PHASE INDUCTION MOTORS



POWDER CLUTCH—CONSTANT SPEED MOTORS

the amplifier pair controlling S_2 can be caused to saturate, thus supplying a greater excitation current to S_2 than exists in S_1. Actually the current in S_1 may be caused to decrease as that in S_2 increases. This results in the rotation of A in a particular direction. Reversal of this command signal polarity will result in a reversal of the described conditions; i.e., the current in S_1 now becomes greater than that in S_2, thus resulting in reversal of the direction of rotation of A. This control circuit has been used on series motors as large as 4 hp in size and has exhibited a servo bandwidth of 3½ cycles with these motors.

Three-Phase Induction Motors

This is a three-phase induction motor control circuit which may be used in position servomechanism requiring motors up to 10 hp in size. Reversal of motor M is accomplished in this circuit by appropriate switching of the magnetic amplifiers L_1, L_2, L_3 and L_4. The condition of $e_{1\text{-}2} = 0$ results in equal and high magnitudes of reactance in each of the amplifiers and since this is the case, no rotation of motor M occurs.

If now an input signal of positive polarity $e_{1\text{-}2}$ is impressed on the amplifiers, then reactors L_2 and L_3 will be radically reduced in reactance while L_1 and L_4 will be increased. A consequence of this action will be a rotation of M in the clockwise sense, for example. The opposite polarity of $e_{1\text{-}2}$ will result in desaturation of L_2 and L_3 with an increasing saturation of L_1 and L_4, thus counterclockwise rotation of M will occur. It may be noted that lines $L1$ and $L2$ are reversed by the foregoing operations and that the reactor L_5 remains unaltered by these actions. Reactor L_5 is utilized for balancing the motor currents under conditions of full reactor saturation either for the combination of L_2, L_3 or L_1, L_4 and represents in magnitude the unsaturable reactance of these reactors under full saturated conditions.

Powder Clutch—Constant Speed Motors

This circuit, similar to the amplidyne generator control circuit, is capable of much higher servo performance. Here a half-wave type high speed amplifier is employed to effect the switching of two powder clutches in accordance with the command signal polarity of $e_{1\text{-}2}$. Servo bandwidths of 12 to 15 cycles may be attained with this circuit for motor sizes up to ¼-hp. Applications have included cross slide positioning in machine tools, fuel line control, damper control and aircraft control surface manipulation.

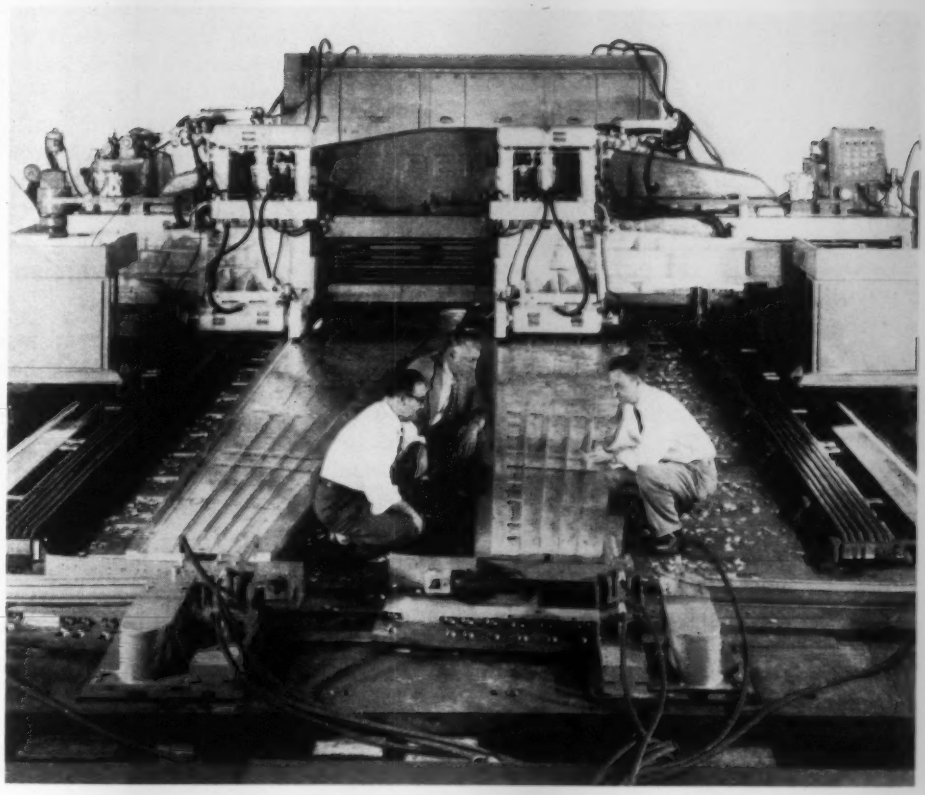


Fig. 1—Betts pit type planer converted to simultaneously mill two integrally stiffened wing outer panels. Straight ribs, either parallel, or converging, can be cut on the converted machine.

AIRCRAFT SKIN MILLER

SHOWS POSSIBILITIES WITH AUTOMATION

By W. C. KRAFT
Chief Designer
Simmons Machine Tool Corp.
Albany, N. Y.

Application of suitable drive and control equipment to perform operations automatically is not limited to new machines—existing machines may be added to or converted successfully for automatic operations. Unusual possibilities with automatic operation are revealed in the 90 per cent time savings realized in production.

CURRENT TRENDS in the aircraft industry demand improved machines for the production of complex components such as integrally stiffened wing panels. Former machining methods based on manually operated units have been found too slow, too expensive or too inaccurate. To meet such problems, North American Aviation Co. had Simmons Machine Tool Corp. convert a conventional planer into a two-spindle skin milling machine which can automatically sculpture aircraft wing panels in a fraction of the time required by manually controlled machines.

Now that it has been converted the machine is capable of milling integrally ribbed structures from 75 ST aluminum stock. Individual ribs are of straight line T configurations varying in thickness and in height, and may be either parallel to each other or convergent. Material left between

the ribs varies in height along the ribs as well as at right angles to the ribs.

These workpieces require controlled three-dimensional movement of the cutting heads, and three modes of operation are provided: automatic, semi-automatic, and manual. During automatic operation the machine can automatically make parallel cuts and index the heads across the work. Semi-automatic operation allows the machine to make an individual longitudinal cut and return to its starting position. The manual circuit is used for indexing of the cutter heads across the work and for making all diagonal cuts.

Five leading edge skins can be placed on five separate vacuum chucks, or two wing outer panels can be placed on two indexing vacuum chucks as shown in *Fig.* 1. The chucks are placed on a work table of steel plates located between the machine bed ways and mounted on the machine foundation.

Before Conversion

Originally the planer was a Betts pit type unit having two parallel beds or ways, one on each side of the work area. Saddles riding on the ways carried a gantry or rail which spanned the work area. Mounted on the forward face of the gantry were two planer heads. Two lead screws, one in each bed, traversed the saddles and gantry along the beds. These lead screws were driven through gear boxes by a single 50-hp 200 to 1200-rpm dc motor. Speed of gantry movement under this arrangement ranged from 176 inches per minute to 88 feet per minute.

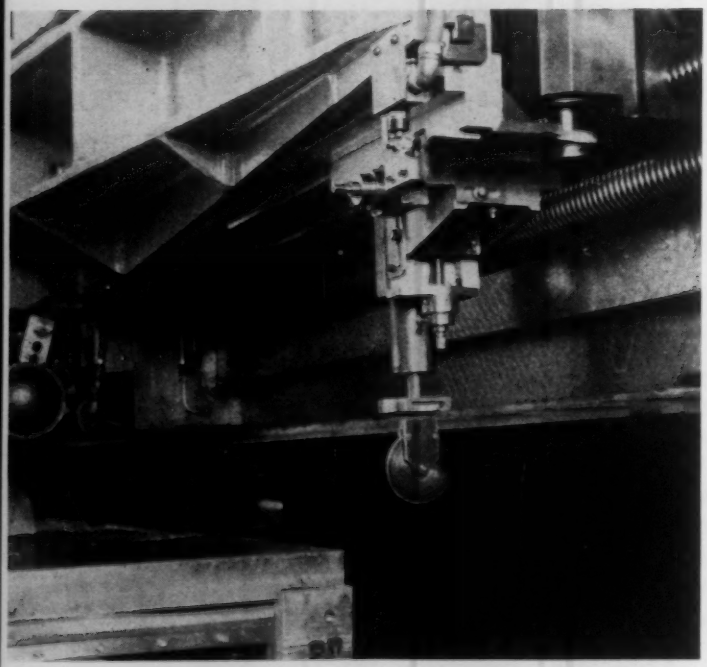


Fig. 2—Each of the two cutting heads is controlled independently with respect to rise and fall and cross-feed on the gantry. Rise and fall are determined by hydraulic tracing heads such as this which follow templates mounted along the ways.

After Conversion

Each planer head was replaced by a 60-hp 3600-rpm Onsrud milling head. The movement of each head along the gantry is powered by an individual 5-hp dc motor, and the movement of the gantry along the beds is powered by the original 50-hp motor. The electrical controls designed for the conversion permit these motors to operate over wide ranges of speeds. Traverse speeds of the milling heads on the crossrail range from 5 to 62 inches per minute in both directions and are accomplished electrically without need of gear changes. Movement of the converted gantry ranges from 20 to 150 inches per minute in either direction for cutting, and from 14 to 88 feet per minute for rapid traverse in either direction. This range from 20 inches per minute to 88 feet per minute is also obtained electrically through the motor with no gear changing being required.

Positioning of each cutter head on the gantry is accomplished by the use of a cross-slide indexing device based on an index bar with locator pins set for the individual cuts, a series of solenoids which position engaging pins to contact the index pins, and a limit switch and dial gage mechanism. In operation, a solenoid is energized that causes the engaging pin to contact the proper index pin. As the cutter head moves on the crossrail it carries the index bar along by the contact between these two pins. When the head has traveled to the preset location, the index bar contacts the limit switch and gage mechanism and stops the travel of the cutter head. This indexing is accurate to within plus or minus 0.001-inch in manual operation and within plus or minus 0.002-inch during automatic operation.

Vertical movement of each cutter head can be controlled by a hydraulic duplicating mechanism which follows a template. Each head is controlled separately by an individual template package mounted along its side of the machine. The template package consists of the templates needed for a given area. The hydraulic follower mechanism permits an accurate rise and fall of 75 inches per minute and will duplicate the template within 0.002-inch, plus or minus. The template tracing wheel is shown in *Fig.* 2.

The two cutter head carriages are equipped with automatic locking devices which prevent any side movement after the heads have been positioned for a cut. The milling head motors are liquid cooled, and a trough is provided along the bed to carry the coolant. The coolant is picked up from the trough by a pump located on the gantry, and

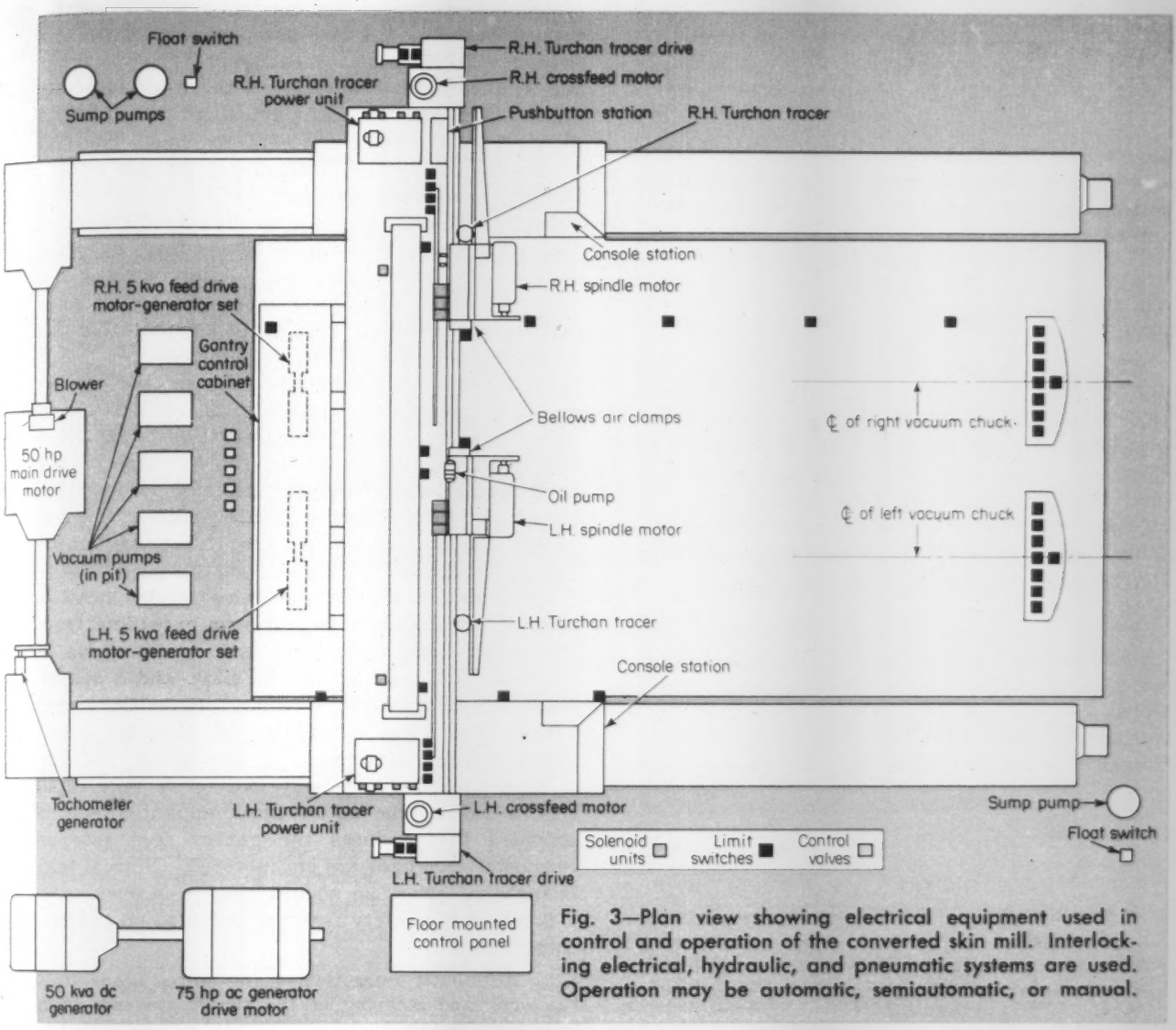


Fig. 3—Plan view showing electrical equipment used in control and operation of the converted skin mill. Interlocking electrical, hydraulic, and pneumatic systems are used. Operation may be automatic, semiautomatic, or manual.

after circulating through the motors, it is returned to the trough. A line taken from the coolant return line provides coolant spray to the cutting tools.

Machine Controls

Controls on the converted machine include electronic feedback systems which provide accurate control over the speeds of the gantry drive motor and the two cross-feed motors. These systems include potentiometers on which preselected speeds may be set. Speeds thus set are maintained within very close tolerances regardless of varying load conditions. With this system it is possible to set horizontal speeds for both the gantry and the cutting heads and move the cutters in diagonal paths. Because of the accuracy of the control, the resulting angular cuts can be held to close tolerances.

Two console type control stations are provided, one for each side of the machine, and are mounted on the gantry. The operator at each console station has complete and independent pushbutton control of his cutting head—cutter motor *Start* and *Stop*, cutter *Up* and *Down*, speed of cross-feed motor, cross-feed *In* and *Out*, cross-feed selector for automatic indexing, etc. Gantry traverse and speed may be controlled from either one of these stations as determined at another panel on the gantry. Pumps for the hydraulic duplicators, coolant, and lubrication are also controlled from gantry mounted controls, and so is the chip collector.

At a control panel mounted on the floor there is a variable reverse feed rate selector for gantry travel and *On-Off* switches for the generators, sump pumps, vacuum pumps, chip separator, and chip conveyor. Location of much of the electrical equipment for the machine is depicted in *Fig.* 3.

To automatically co-ordinate the functions of the indexing devices, stepping switches program the machine motions. There is one stepping switch in each operator's console station, and they can be easily plugged into or unplugged from the circuit. Each switch can be preset to provide the proper

sequence of operations. Since the stepping switches as well as the indexing devices are easily changed, entirely different wing panels can be cut after a limited changeover time.

Special Features

When the machine is operating automatically, the cutters traverse the length of the work, rising and falling as determined by the contours of the templates. At the end of a cut the cutter heads rise clear of the work and begin the return traverse. During the return traverse the cross-feed indexing of the cutter heads takes place; the chucks are indexed if indexing chucks are being used; and the hydraulic tracer is indexed to the next template.

Automatic cross-feed indexing is electrically controlled through hydraulic and pneumatic equipment sketched in *Fig.* 4. The vacuum chucks which can be indexed are also controlled by a combination electrical - hydraulic - pneumatic arrangement. Each chuck is made from a large plate which has a groove around the periphery of its top surface. A vacuum pump connected to this groove withdraws air beneath work placed on the top surface of the chuck, thus the work is firmly held. One end of each indexing chuck pivots about a pin through the opposite end. The end of the chuck farthest from the pivot pin is connected to a chuck indexing device, *Fig.* 5. The chuck is moved by the long hydraulic cylinder, and its correct position is determined by limit switches on the indexing bar. After reaching the correct position, the chuck is securely locked by a locking pin which is moved into an accurately located index pin hole by an air cylinder.

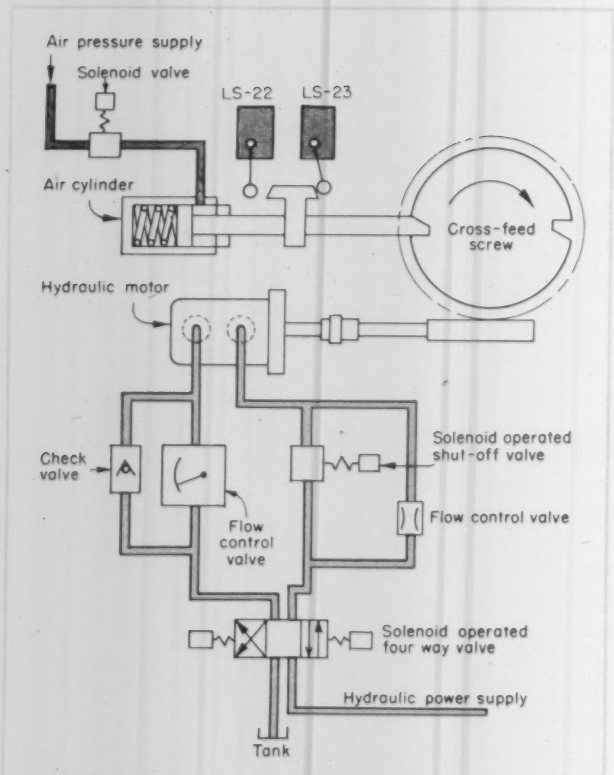


Fig. 4—Sketch illustrates the cross-feed indexing device. Stepping switches control the sequencing of automatic actions on the machine.

In addition to the vacuum chucks, the tooling provided includes: Two sets of rise and fall cam bars (templates), one for each cutting head; index bars with engaging pins for the indexing of the cross-feed motion of the cutter heads; visual index plates for the cross-feed heads and for the hydraulic tracers; and work and cutter positioning fixtures.

As shown in *Fig.* 2, the tracer stylus head is mounted on a slide riding an arm extending from the cutter head. The hydraulic tracer valve is mounted in a carriage on the slide, and a special extension with tubular bearings carries the stylus wheel. The wheel is mounted in a bracket which allows lateral adjustment of the wheel position.

Since the cam bars may call for a very rapid rise or fall of the cutter head, an anticipator is provided that reduces the gantry feed rate as these steep changes are encountered. Normal feed is resumed after the sudden change is over.

Some of the safety features provided on the machine include:

1. Automatic retraction of the cutter heads from the work and stopping of the gantry traverse when the cutter motors become overloaded or overheated.
2. Automatic retraction of the cutters, stopping of the gantry, and lighting of a signal in the event of any failure in the vacuum system.
3. Automatic retraction of the cutters and stopping of the gantry in the event of failure in the coolant system.
4. Overload relays on all motors.
5. Automatic retraction of the cutters and stopping of the machines upon any failure of the cutter head rise and fall mechanism.
6. An air jet which is directed at the templates to blow off any chips.
7. Telescoping way covers that are provided to protect the gantry ways from chips, dirt, or coolant, and to prevent contamination of the oil in the oil troughs.
8. Indicator lights to inform the operator which particular unit has failed.

A Typical Operation

To illustrate the functioning of the machine, a typical operation cutting integrally stiffened, converging rib type wing panels can be used as an example. Before the machining begins the machine must be tooled and set up for the job. This

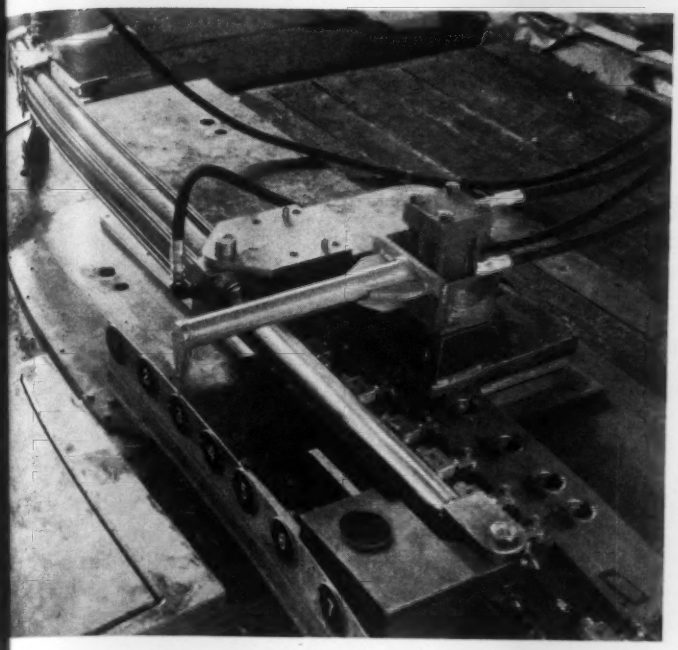


Fig. 5—Vacuum chucks holding the panels can be automatically pivoted about one end by an indexing mechanism like this at the opposite end. The long hydraulic cylinder moves the chuck, and the pneumatic cylinder seats an index pin for positive positioning. The scale and pointer give the operator a visual check on the indexing.

includes the steps of:

1. Setting the template packages in their holders on each side of the work surface.
2. Setting the chuck indexing mechanism for the correct position.
3. Plugging in the stepping switches which will control the sequence of operations.
4. Installing the cutter head index bars.
5. Installing visual index check bars.
6. Placing the workpieces on the chucks and drawing the vacuum.
7. Aligning the stylus and cutter in correct relationship to the templates and work.
8. Checking the functioning of all auxiliary equipment.

When the machine is ready for operation, the operator consults his cut sequence planning chart and, using the manual circuit, brings the work and cutters into their starting positions. Using the manual circuit, the operator starts the cutters, moves them down into the work, and traverses the gantry to take a cut on the center of each workpiece. Two more cuts are taken, one on each side of the work. These first cuts relieve stresses in the material and allow it to remain flat.

After the relieving cuts are made the operator again positions the cutter and chuck, sets the feed rate for the gantry on the gantry potentiometer, and starts the automatic cycle. During the automatic operation the actions of cutter rise and fall, return traverse, chuck and cross-feed indexing are performed in proper sequence. At the end of the return traverse the operator quickly checks the visual indicators to determine whether all indexing has occurred properly. In the event of any malfunctioning, he pushes the *Emergency Stop* button and brings all operations to a halt.

When all indexing has proceeded correctly, the cutters again descend into the work and make the succeeding cut. This cycling continues until all cuts have been completed. Although the cutter head and stylus must index for each new cut, the chuck may remain in one position for several cuts. Since all cuts do not traverse the same length of the work, an arrangement on the template can retract the cutter and automatically reverse the gantry at different points. This eliminates waste time when the cutters are not removing metal.

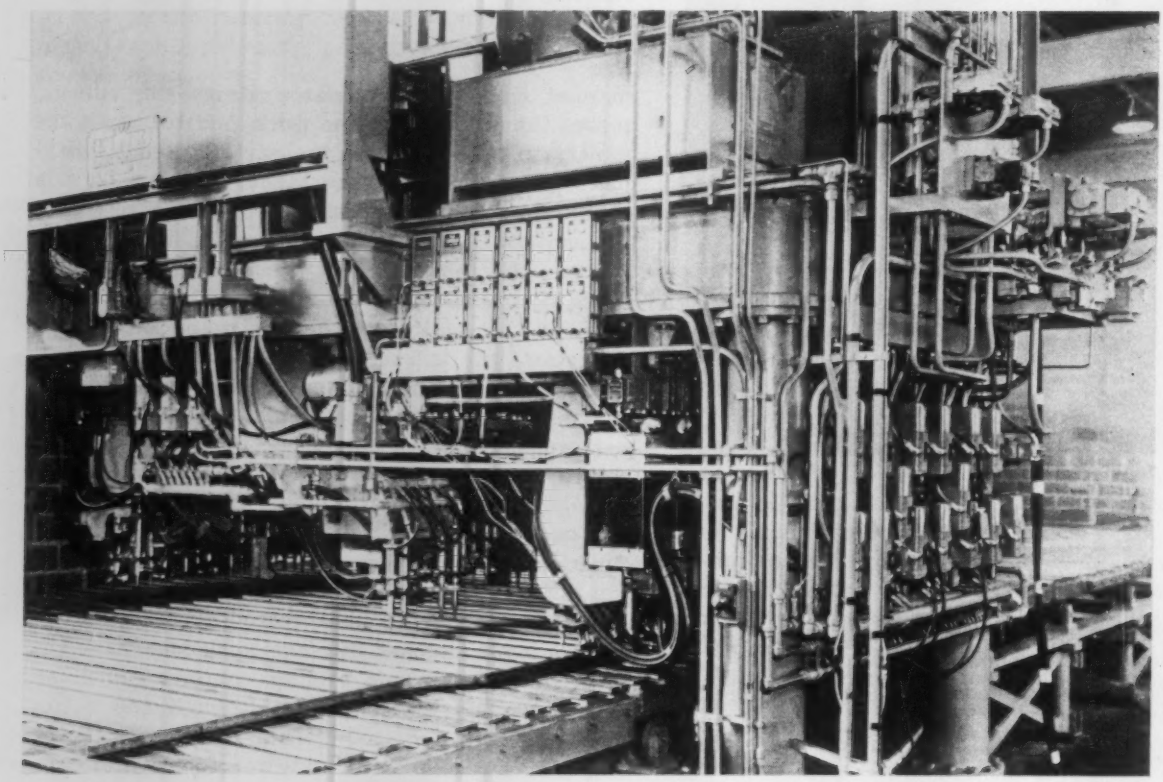
For the machining of the wing panels shown in *Fig.* 1 there were 38 index positions for the cutter heads and 7 positions for the vacuum chucks. Cutting time for the integrally stiffened wing panel was reduced by the skin mill from 60 to 3¼ hours. This improvement of production is illustrative of results which can be obtained by application of automatic controls to machine tools, new or old.

Outsize Flame Hardening

IN SATISFYING the demand for large, massive automated equipment, the machine tool industry is receiving the co-operation of many collateral enterprises. For example, an important contribution to large transfer type, in-line installations is made by flame hardening, as typified by the services rendered by the Detroit Flame Hardening Co.

Application of flame hardening, being practically instantaneous in action, requires that each job have the most precise control of the flame quench cycle over the work area to be hardened. With the development of automatic flame hardening equipment the process is no longer limited to gears, cam wear surfaces and other similar small items. Indeed, one of the real advantages of flame hardening is to be gained in the field beyond the range of furnace or induction hardening equipment, since flame hardeners use no furnaces and are therefore free from work size limitations.

With the ability of automatic flame hardening equipment to impart wear resistance in a selective manner, it has been possible to integrally cast machine ways right into massive machine bases. The resulting structure is sound and affords excellent degree of rigidity and permanence of alignment.



CORRUGATED SHEET WELDING

AUTOMATIC WELDING of side walls and roof sections of Fruehauf Trailer Co.'s corrugated steel Volume Van trailers is accomplished by a special Link Welder Corp. machine. Parts for the entire side wall or roof are preassembled on the machine bed. Automatically, the entire assembly moves under the complicated welding head where each weld is accurately located and timed. Illustrated is an application of the Link machine to the welding of a complete side wall of a trailer. As can be seen, the multihead welder makes use of electronic, electric and hydraulic devices in securing the proper pressure and time of weld at each point.

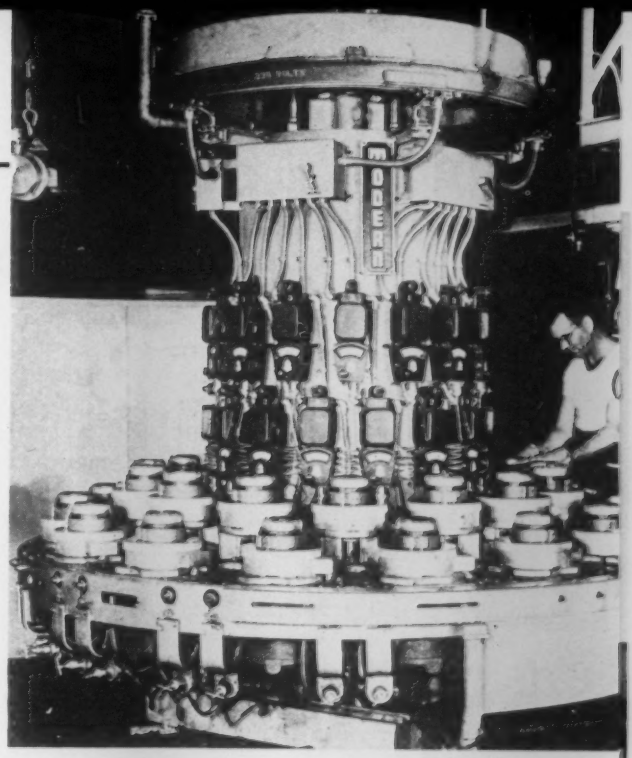
PACKAGING WIRE PRODUCTS

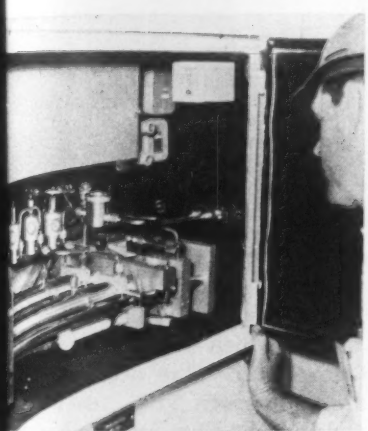
WIRE and similar stranded materials are automatically packaged in long continuous lengths with equipment developed by Coulter & McKenzie Machine Co. Shown in use at a plant of Madison Wire Co., Buffalo, N. Y., the equipment is placing up to 600 lb of specialty wire in cartons. Users can pay out wire with maximum freedom from tangles and scrap losses. Definite advantages have been noted by industries processing speedometer shaft wire, stapling wire, flexible shaft wire, rope and aircraft cable, wire, etc. Basic packaging equipment which feeds the wire into the cartons is available for attachment to existing machines.

in action

BONDING MACHINE

BONDING transmission brake linings to metal bands is an operation requiring the constant application of pressure and heat for periods ranging from 7.5 to 10 minutes (depending on the size) for parts produced by Warner Gear Div., Borg-Warner Corp. A special 30-station machine has been developed and built by Modern Industrial Engineering Co., Detroit, Mich., to automate all but the load and unload operations. Adhesive coated molded brake band linings are placed inside the metal bands to which they are to be bonded and loaded onto a segmented mandrel. Air pressure forces mandrel jaws apart as heat is applied. As the machine indexes, a cam on the outer periphery of the machine releases the pressure at proper points to allow gases to escape during the bonding. Pressure and temperature at each mandrel can be automatically controlled.



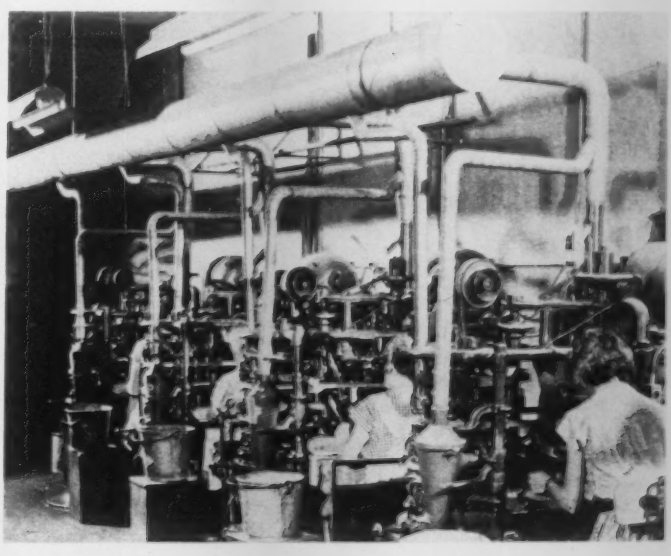


CHEMICAL ANALYSIS

INFRARED ANALYZER application at Brea Chemicals Inc. is used to prevent catalyst poison in reactors producing ammonia. The analyzer continuously measures CO concentration in a hydrogen-nitrogen mixture to an accuracy of 1 ppm. The Cary infrared analyzer, a product of Applied Physics Corp., Pasadena, Calif., automatically cycles every 12 minutes between two sample streams and automatically restandardizes against a reference gas every 30 minutes. The dual beam, non-dispersive instrument employs two separate condenser microphone detectors which may be independently sensitized to absorb radiation only in the wave length region usable in the analysis.

DOUBLE DUTY DUST COLLECTOR

SURFACE GRINDERS, facers, shapers and drillers used in the production of buttons from clam shells also produce, as a byproduct, shell dust which must be collected and disposed of. Muscatine Pearl Works, manufacturers of buttons, uses Pangborn Corp.'s CH-3 self-cleaning collector in a novel setup to control dust around the various machines and in addition, to move finished buttons from a final machine station to a collection station. Blank buttons are placed by hand on rotating chucks which index as the blanks are faced, shaped, patterned, cut and drilled. At the end of the cycle, the air stream picks up the finished button and deposits it in a pail at the left of the operator. The size of the operation? In the production of 7,200,000 buttons per week, approximately 8 tons of shell dust (used as animal feed ingredient), are collected.



DATA PROCESSING

COMPUTER-COMMUNICATION system for supply management has been established by the Army Signal Corps. Key element in the system is International Business Machine Corp.'s electronic computer IBM 705 which for the Signal Corps network handles requisitions, stock control and other data pertaining to signal equipment supply for the entire U. S. Army. Specifically the unit is designed to: Collect and memorize eight million facts about 150,000 different electronics items used by the Signal Corps; make 37,500 changes per day to the basic facts within 24 hours after the changes occur; process 6000 orders per day for supplies received from troops throughout the world; review all items each day to determine which are in short supply and should be ordered or have existing orders changed to reflect up-to-the-minute additions.

FLOW-RATIO CONTROL PROVIDES CONTINUOUS FLUID MIXING

FLOW-RATIO control is one means to eliminate batch processing in favor of continuous processing. Actually it is a system in which the smaller quantity is automatically metered into the stream of the larger quantity. Flow of the main stream must be measured and the desired ratio selected as the set point so that the controller can actuate the valve controlling the smaller quantity flow.

A unique flow-ratio control system, engineered by Leeds & Northrup Co., holds the ratio of two liquid flows with an accuracy in the order of 0.5 per cent. A large Eastern chemical company specified this high overall system accuracy for a continuous process involving the addition of a small amount of reactant to a main stream flow. Placed

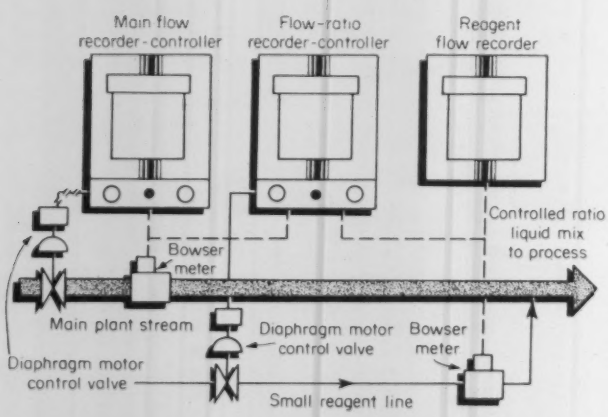


Fig. 1—Schematic diagram of L&N flow ratio control system. Two tachometer generators driven by Bowser flow meters measure flow in the two streams. These measurements are utilized by the controller which actuates a diaphragm motor valve on the smaller reagent flow line to produce the set-point ratio.

in service recently, the system has continued to meet design specifications and is actually proportioning the two flows with an accuracy of about 0.1 per cent.

The system has many applications in process industries where high accuracy of flow ratios is required. It provides permanent chart records of both flow rates and of the controlled ratio, as well as convenient adjustment of the desired ratio —all from a remotely located panelboard. Total flow is indicated at the panelboard by an electronic counter connected to the main stream meter. A switch diverts the mixed liquids to successive process vessels after a preset quantity has been metered to one process vessel.

Primary elements for the two flows are Bowser, piston-type, positive displacement meters with minor design changes to meet the high accuracy requirements. Each meter converts fluid flow into shaft rotation and the shaft is geared to a tachometer generator. By this means, volumetric flow rate is translated into a proportional electrical analog voltage which is indicated on an L&N Speedomax strip chart recorder.

As shown in *Fig.* 1, separate meters on both process lines are connected to separate recorders. The main stream flow recorder also includes a pneumatic control unit for automatic control of this flow by means of a diaphragm motor valve. This controller is adjusted so that it merely smooths out wide variations in the main stream flow rate, instead of holding rigidly at a preset value.

A separate Speedomax instrument records and controls the flow-ratio. Parallel electrical leads from the two tachometer generators are connected in the instrument bridge circuit which provides an accurate measure of the flow-ratio. The desired process ratio is set by an adjustment knob (set point) on this controller and indicated by a pointer on its calibrated scale. This controller has proportional, reset, and rate time type of pneumatic control, used to maintain the set ratio by positioning a diaphragm motor valve on the smaller reagent flow line.

Certain design specifications, added to meet the needs of the chemical plant application, include:

1. A higher than normal gear ratio in each Bowser meter to increase rotational speed of the output shaft driving the tachometer generator. This helps to minimize the error in measurement of relatively low flow rates (5 to 50 gpm).

2. Tachometer generators accurately checked for linearity of output voltage versus speed, and carefully matched. This increases the measurement accuracy.

3. Electronic gain setting on the flow-ratio recorder controller arranged so that the instrument has higher sensitivity of measurement at lower flow rates.

4. A pulse contact added on the main stream meter to actuate an electronic counter. This device totalizes the quantity of flow and initiates the switching action to divert the mixed liquid stream.

The specified ratio range for this application was from 9:1 to 12:1. However this can be designed for almost any desired range to suit process requirements. The type of flow measuring device employed is known to be suitable for accurate metering of a variety of liquids such as gasoline or similar hydrocarbons, corrosive chemicals, oils, fluid plastics that won't congeal, and sucrose solutions.

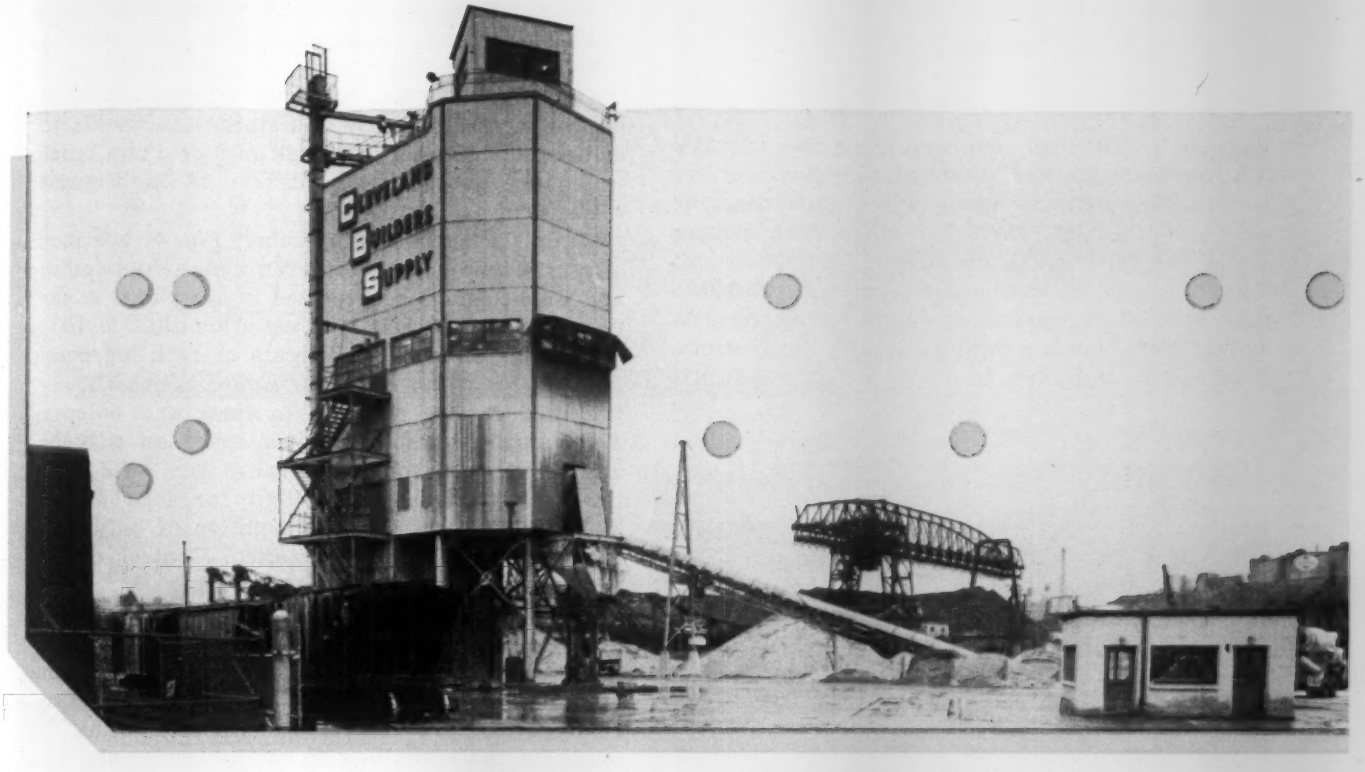


Fig. 1—General view of the batching and mixing plant in which punched cards can automatically control delivery of specified ingredient weights. Ore bridge in background is across the river on which freighters bring aggregates to the plant.

PUNCHED CARDS CONTROL AUTOMATIC BATCHING

If company plans and policies present the opportunity to consider application of modern equipment not previously used in their industry, a company can install equipment, just as this building materials firm did, which leads to improvements in quality and costs.

BATCHING of ingredients is the heart of many operations. In preparing batches of concrete, as in similar batching tasks, consistent accuracy and speed in weighing out ingredients are major factors in determining product quality and the profit level of the operation. When Cleveland Builders Supply Co., Cleveland, Ohio, was forced to build new facilities because freeway and river projects eliminated existing installations, they chose a plant design in which batches could be automatically prepared from specifications recorded on punched cards. The system, developed by Fairbanks, Morse & Co. in collaboration with Butler Bin Co., can automatically weigh out batches containing as many as two out of three cements, up to four of six aggregates, required water, and special additives. Up to 6 cubic yards of concrete can be batched and mixed every 2 minutes.

▶ Batching Control

Materials are fed to the batching equipment from two large multi-compartment bins located in the top of the 100-foot high reinforced concrete

PUNCHED CARDS CONTROL AUTOMATIC BATCHING

and structural steel plant building, *Fig.* 1. The operator's station and the batching equipment are located about 70 feet above the ground near the outlets of the bins. Three Fairbanks-Morse hopper scales are used in the installation: a 5000-lb unit with 5-lb graduations handles cement, a 25,000-lb scale with 25-lb graduations weighs out aggregates, and a 2000-lb water scale has 2-lb graduations. Feeding of materials to these hopper scales is controlled from the operator's console; automatically by punched cards, *Fig.* 2, or manually by pushbuttons on the console, *Fig.* 3. Operation of the mixer into which the scale hoppers discharge is also controlled from this station and so is the delivery of material to transit mix or dump trucks which the operator can observe through grated windows at his feet, *Fig.* 3.

Cards for automatic batching, *Fig.* 4, are made of plastic for permanence even under the handling and conditions to be expected in the plant. A card is prepared for each mix variation that is to be batched automatically. Weights of each ingredient selected are recorded by punching holes through the card in the appropriate lines and columns. The punching system used is based on a binary decimal system, sometimes called the 8-4-2-1 system, that represents the digit for each decimal place by the necessary combination of only those four numbers. (See—"Numerical Control of Machine Tools," AUTOMATION, Oct. 1956).

To start an automatic batching cycle the operator inserts a punched card into a card reader. This reader is made of plastic with silver buttons embedded in one wall of the card slot in positions corresponding to possible hole locations on the card. On the opposite side of the reader slot is a pin assembly which moves forward to make contacts with the buttons. Where a hole is present in the card the corresponding pin goes through and makes contact with its associated button. For each ingredient specified, a voltage is established that is proportional to the desired weight. Load cells sense the quantities fed to the hopper scales, *Fig.* 5, and voltages proportional to the actual weight in each hopper are established. Sand, cement and water (when used) start feeding simultaneously into their respective hoppers. Materials are fed to the hoppers until the voltages of desired and actual weights are balanced. Weights of all ingredients are then applied to the aggregate scale system while the coarse aggregate is

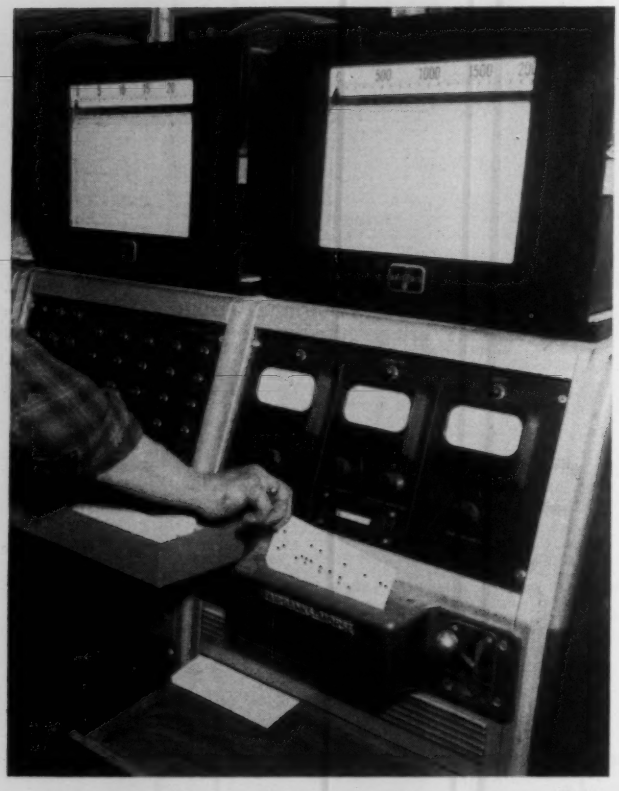


Fig. 2—For automatic batching the operator merely inserts the desired card and presses the actuating lever to initiate the accurate weighing out of water, selected aggregates and cement.

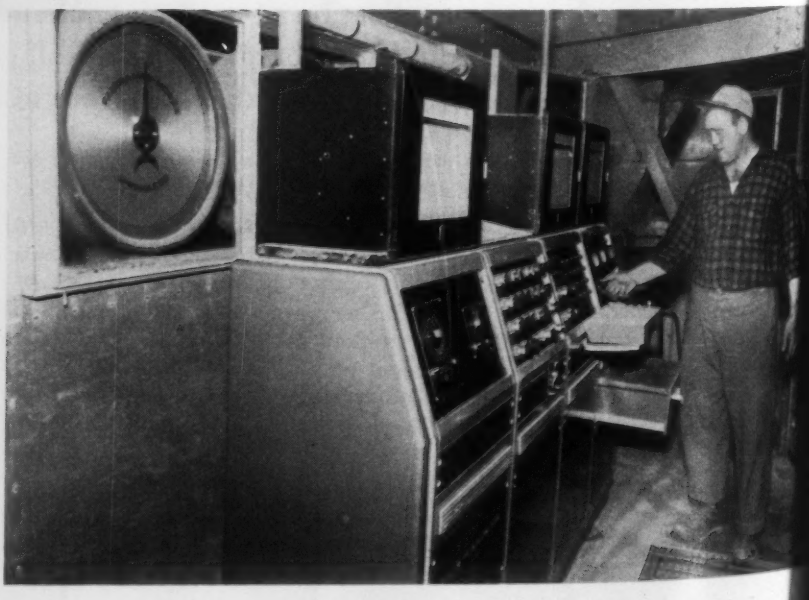


Fig. 3—By means of the pushbuttons shown, the operator can manually control opening of gates and valves and operation of screw conveyors, noting quantities fed by means of scale dials visible through the wall of the operator's station. Windows in the floor permit observation of mixing and loading activities below.

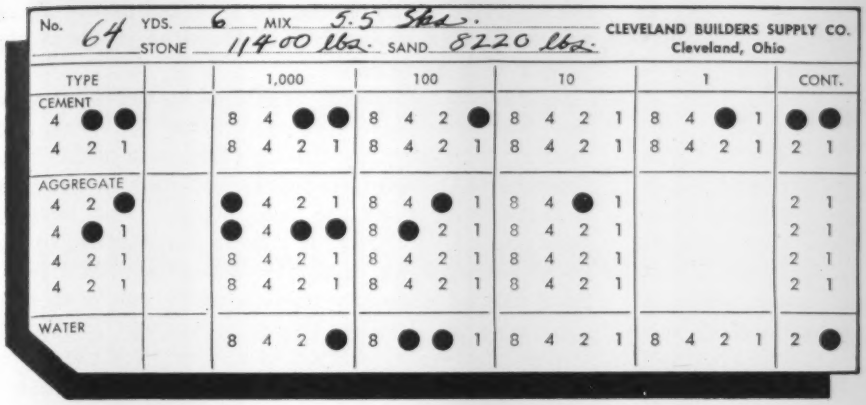


Fig. 4—Plastic cards such as this are used to record desired mix specifications. Provision is made to automatically feed selected types of cements and aggregates and desired weights of those materials and water. This data is handled by a binary decimal system which uses only the numbers 8,4,2 and 1.

fed in until the correct total weight specified for the mix is reached.

Feeding From Bins To Trucks

Three screw conveyors, visible in *Fig.* 5, transfer cement from the compartments of the cement bin to the cement hopper scale. The drives for these conveyors are equipped with pneumatically actuated clutches which automatically switch from high to dribble speed motor drive as the amount of cement in the scale hopper approaches the specified weight. In delivery of coarse aggregate and sand by gravity from the aggregate bin to their hopper scale, provision is made for cutting off the flow as the desired weight is approached, to compensate for the material still in suspension in the hopper. Water is introduced rapidly through a main valve and then at a slower rate through a smaller valve. After the weighing operations are completed, a *Batch complete* signal light flashes on. When released by the operator, all three hopper scales then discharge in a pre-set sequence into the 6 cu yd tilting mixer. Interlocks in the control system prevent the delivery of material to the hoppers while the hopper discharge gates are open. Bin gates and valves in the plant are automatically actuated by solenoids which, in the case of bin gates, operate valves controlling pneumatic cylinders.

After the concrete has been mixed, the operator presses a button and the mixer is tilted and discharges into a surge hopper. Transit mix trucks are loaded from this hopper through a sleeve spout and a pneumatically actuated valve. The mixing plant operator also controls this loading action. The surge hopper allows him to batch and mix the next batch while the previous batch is being loaded into a truck.

Batches of dry ingredients may also be weighed out. Such batches bypass the mixer by means of a flop gate which diverts the flow to a separate discharge point. Bulk trucks can be loaded with such dry batches at the same time that wet mix trucks are being loaded from the surge hopper.

Automatic compensation is made in the feeding

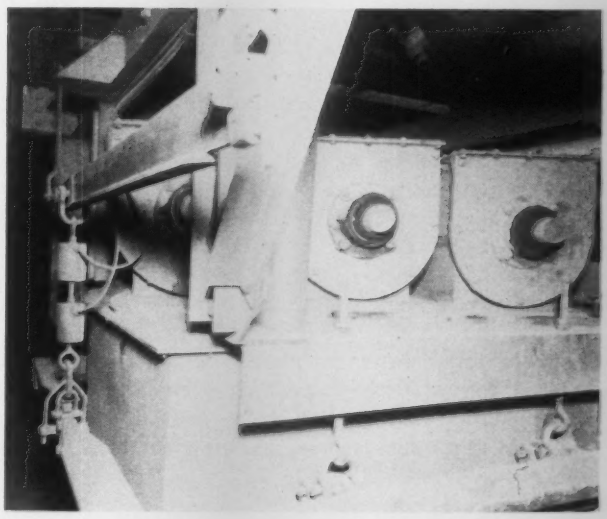


Fig. 5—Cement is fed from the three compartments of a large bin by screw conveyor to this hopper scale system. The load cells visible at left are used to sense the quantities fed when batching is automatic.

of sand to adjust material quantities to a dry weight basis. The moisture content of the sand being used is determined periodically by standard tests, and this moisture percentage is set on a dial at the operator's console. Adjustment of the quantities of water and moist sand are then automatically made to give quantities corresponding to dry weight specifications.

Operation of the system may be accomplished manually by use of pushbuttons which control individual feeding actions. In such operation the weights fed to the hopper scales can be observed on scale dials visible from the operator's station. Weights of materials fed to each scale for automatic and manual batches are recorded by means of Bristol continuous strip chart recorders. A written record for each batch is thus prepared.

Supplying Materials

Most of the aggregates are brought to the plant by freighters which come up the Cuyahoga River from Lake Erie to the plant dock. These freighters

are self unloading units with boom conveyors which deposit sand and stone directly on Cleveland Builder's stockpiles. The aggregates are reclaimed from the stockpiles by crane and dumped into hoppers over conveyor belts running along the dock. These conveyors empty onto an underground conveyor which feeds the inclined conveyor system leading to the aggregate bin in the plant building. A motorized turnhead over the bin is remotely controlled to determine which of the six aggregate compartments will receive the material coming up the belt.

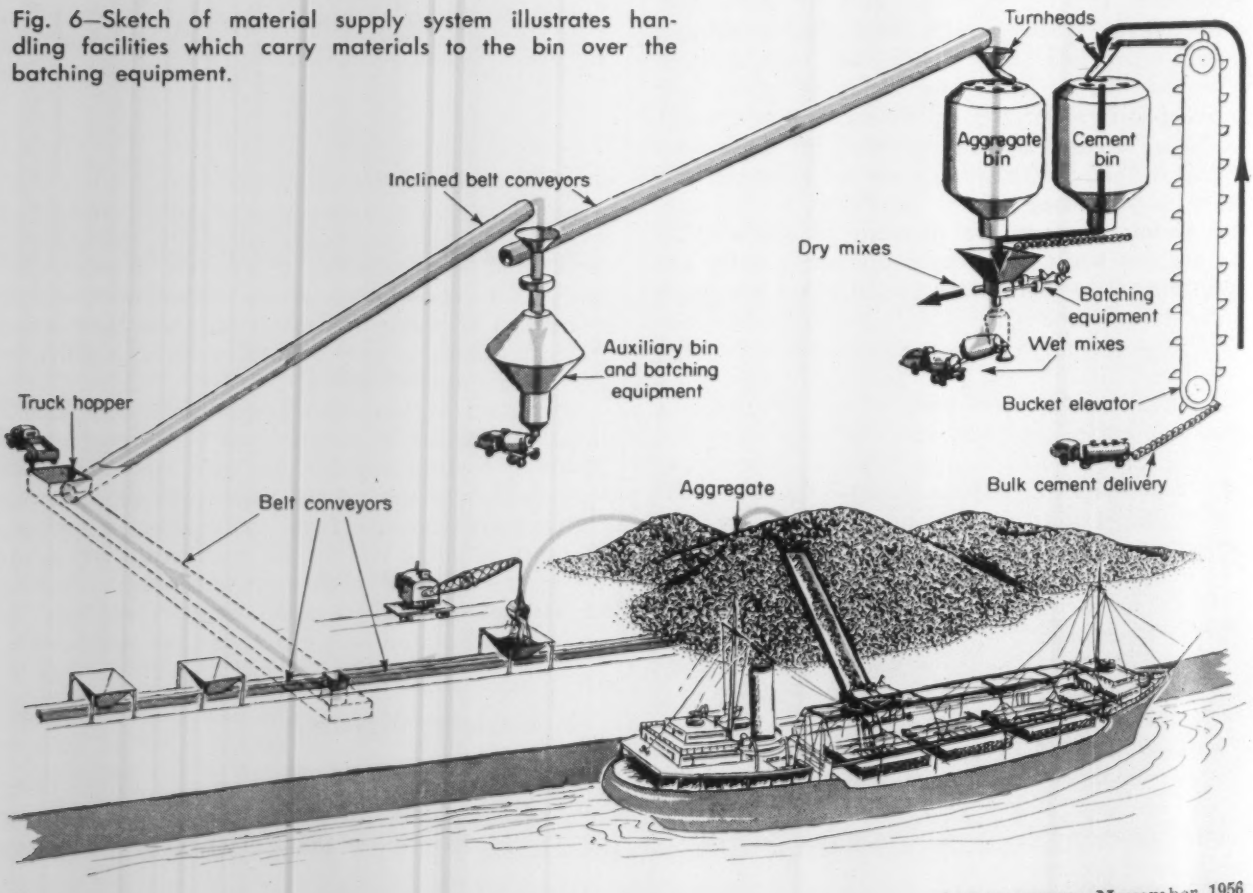
Control of the aggregate conveying system, *Fig.* 6, is possible from either of two stations; one near the foot of the inclined conveyor system, and the other in the plant building. Starting and stopping of the conveyors in the aggregate system are controlled by pushbuttons, and interlocks prevent actions out of proper sequence. Levels in each bin compartment are indicated by lights controlled by signals from high and low level devices. The devices used contain small motors which turn blades when the level of material in the bin does not prevent their rotation. Thus the blades rotate when material is not present at their level, and they stall and cause a driving connection to slip when they are covered with material. An operator responsible for the filling of the aggregate bins checks the level indicating lights and sees that the proper aggregates move to the proper bins as needed.

Auxiliary equipment provided in the aggregate system allows receipt of aggregates by truck, and loading without going through the main plant. Such aggregates, usually special types, are dumped into a truck hopper at the foot of the first inclined conveyor. This conveyor moves the material to a turnhead over an auxiliary bin setup. This turnhead can be manually positioned by cables so that discharge of the first incline conveyor flows to a second conveyor leading to the main plant, or it can flow into one of four compartments in the auxiliary bin. Batching of special materials can thus be performed manually without interferring in main plant operation.

Cement comes to the automatic batching plant by rail or truck and is dropped into a screw conveyor which moves it to a bucket elevator. The elevator carries it to a turnhead above the cement bin in the top of the mixing plant. This turnhead is positioned from the foot of the elevator to discharge into the desired bin compartment. Signals indicating position of the turnhead and bin levels are displayed on a panel near the foot of the elevator.

Water required for the wet mixes can be heated to permit successful pouring of concrete in cold weather. When this is necessary, the water is passed through a high capacity heater as it is delivered to the water scale.

Fig. 6—Sketch of material supply system illustrates handling facilities which carry materials to the bin over the batching equipment.



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SPLINE BROACHING

of transmission part

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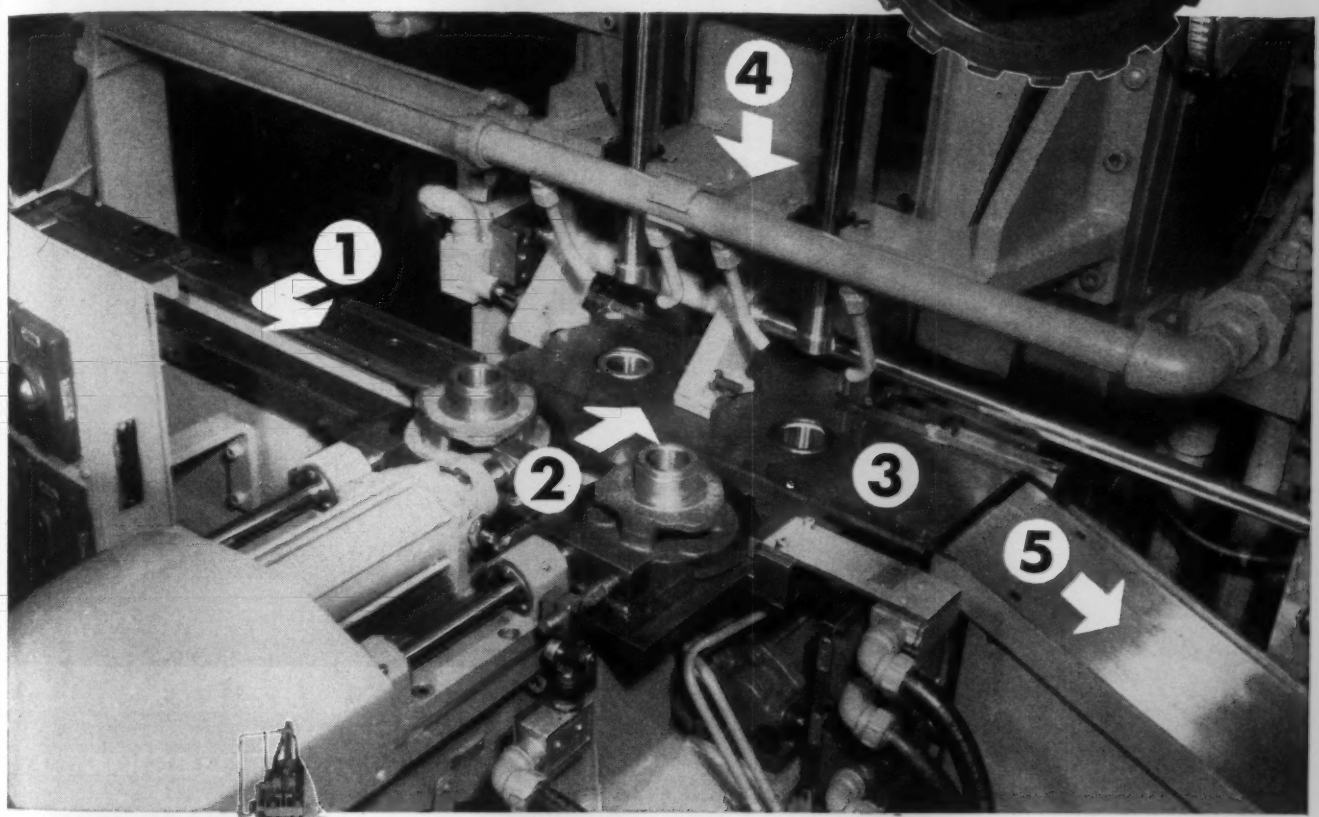

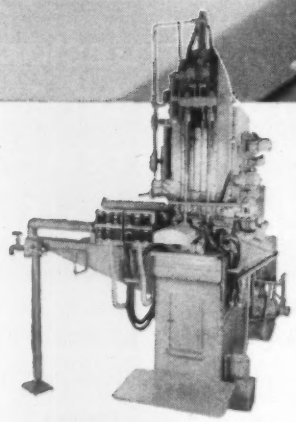

Fully automated broaching by American here results in an output of 380 parts per hour (at 100% efficiency). Regardless of what degree of automation you require, American is prepared to design and build the broaching machine, fixtures and broaches that will fit your production picture best. Write details of your requirements today.

1 Hydraulic fixture, interlocked to the machine cycle, transfers parts laterally, two at a time, from conveyor to position in front of the broaches.

2 Hydraulic pusher carries parts into broaching position.

3 An automatic skid plate then lowers and seats the parts over the thrust bushings.

4 Spline broaches, 36″ long, are pulled down through the two parts, broaching 35 splines in the ID of the hub.

5 As skid plate rises, unseating the parts, hydraulic plunger ejects the parts down inclined chute.

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PLANET DESIGNED TUBE HANDLING SYSTEM
Floats Excess Stock

This Planet system, which was recently installed in an auto plant, automatically handles frame members from tube forming to assembly. Its outstanding feature is the stacker illustrated which provides an automatic float for tubing formed in excess of immediate production requirements. In this installation, the stacker accumulates and bands the tubes on dollies for live storage. This permits efficient use of the forming equipment at timed intervals, while supplying assembly with a steady flow of tubes.

A system of this kind would work equally well for any uniform stock, such as bars, rods or billets. Perhaps it might solve a problem in your plant. Let Planet demonstrate how it can help you. *Write or phone today — there's no obligation.*

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- **AUTOMATED EQUIPMENT**
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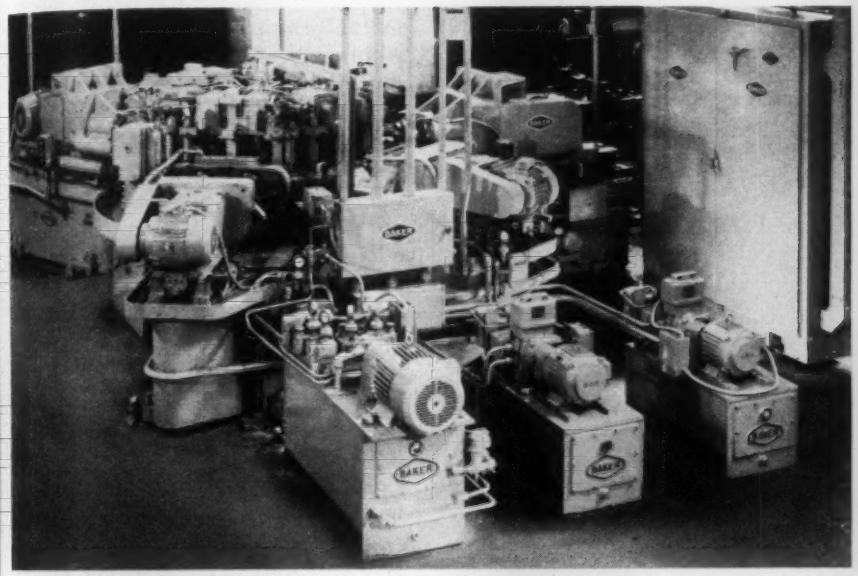
AUTOMATION new equipment

Machines and plant equipment designed for more automatic operations

For detailed information and literature, use card page 17

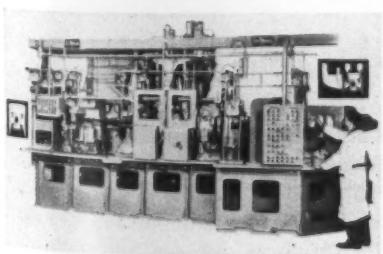


Machining Jet Nozzle Bits Automatically

Multiple operation index table machine is designed to finish jet nozzle bits. Consisting of five stations, the machine's operations are: Load two parts, center drill, drill, counterbore, ream and recess. Each fixture holds two parts, and identical operations on the two parts are performed at every station. Production rate is 123 parts per hour at 100 per cent efficiency. Finished part functions as a bracket to hold one of the cutting heads on an oil well rock drill.

While specially designed to produce jet nozzle bits, index machine is composed of hydraulically operated standard machines which can be retooled for changes in product or production methods. For example, they can be used in battery as illustrated, or used singly, making automation feasible even on lower production runs. **Baker Brothers Inc.**, Toledo 10, O.

Circle 401 on Inquiry Card

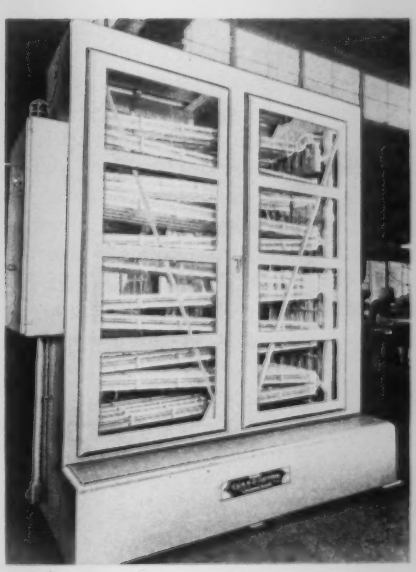


Automated Piston Line

Dial type and in-line type machines are combined to form a single unit in automated piston line. Fully automated unit has 14 stations: Five stations in the dial type section of the unit, and nine stations in the in-line type section. The line machines 400 pistons per hour, and will handle or process any one of three different pistons by changing the position of the selector switch and fixture locators.

Line has automatic lubrication throughout; a chip conveyor is provided in the base of unit. The shuttle system can be adjusted for different size and shape pistons, automatically allowing for future model changes. Pistons, as they come from the mold, (illustrated in inset) are conveyor fed directly to the automated piston line. **LaSalle Tool Inc.**, 3840 E. Outer Dr., Detroit 34, Mich.

Circle 402 on Inquiry Card



Production Stabilizers

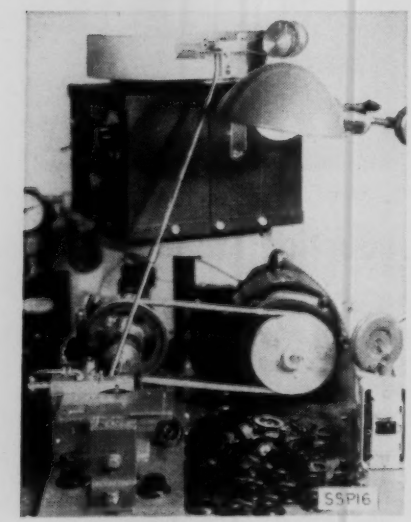
Used to insure continuity of production of any round part such as gears, screw machine blanks, etc., production stabilizer units become an integral part of an automated line. Devices receive a floating and continuously moving bank of parts from the machine ahead and feed parts as needed into the following machine. Stabilizers consist of zig-zag gravity feed tracks and parts elevators.

Design is such that the number of parts in the floating bank may be anywhere from several hundred to more than 5000 parts. Bank size is selected so as to provide

temporary storage and releasing of a number of parts, the processing of which corresponds to the maximum time required to make tool changes on the machine ahead of or following the unit. Thus, tool changes or other adjustments can be made on any machine at any time without causing interruption of production on any other machines in the integrated line. The tower which feeds the machine merely adds parts produced by the preceding machine to those in its floating bank. At the same time, the unit beyond the machine releases parts previously stored in its floating bank to the next machine. Individual machines can be operated at their maximum efficiencies for planned production periods without being limited by production rates of machine ahead or behind.

An automatic size gage may be included at the entry end of the storage tower to prevent entry of an oversize part from the preceding operation. In addition, the fully caged track prevents accidental or intentional introduction of off-limits parts that might damage either machines or tools in subsequent operations. **Gear-O-Mation Div., Michigan Tool Co.,** 17140 E. Ten Mile Rd., E. Detroit, Mich.

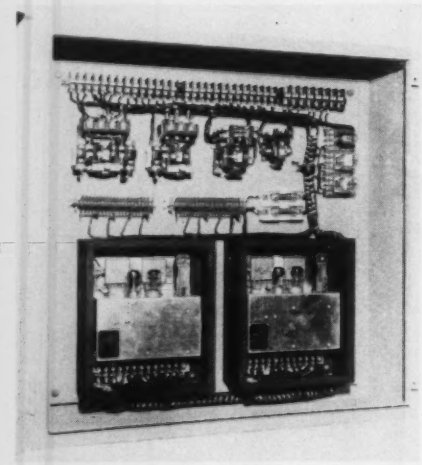
Circle 403 on Inquiry Card



Set Screw System

Available in bench or table model, hopper fed headless set screw system adapts bench and floor equipment to automation. Bench-model hopper feeding mechanism delivers most efficient results when used with Setko hopper-fed headless set screws. Screws are available in a wide variety of points, and are made in three styles: Hexagon and fluted socket, slabbed, and slotted—including self-tapping and self-locking types. In operation, the screws are automatically channeled from a vibrating hopper down a guide tube directly to the work, right side up and properly positioned for fitting. **Set Screw & Mfg. Co.,** Bartlett, Ill.

Circle 404 on Inquiry Card



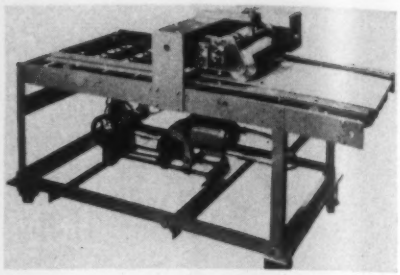
Synchronizing Control

Designed to microposition two parts in a stamping press and coordinate press operation with subsequent equipment on an automatic production line, synchronizing controller reduces seven manual operations to one automatic process. Electrical panels and systems for all types of automatic machinery and processes are custom designed, constructed and pretested to perform control functions ranging from automatic gaging, sorting, counting, packaging and signaling to integrated sequencing systems for assembly machines, transfer equipment, machine tools and food processing operations. Controlled actions may be mechanical, chemical, pneumatic or hydraulic in nature. **U.S. Controls Inc.,** 161 Grand St., New York, N. Y.

Circle 405 on Inquiry Card

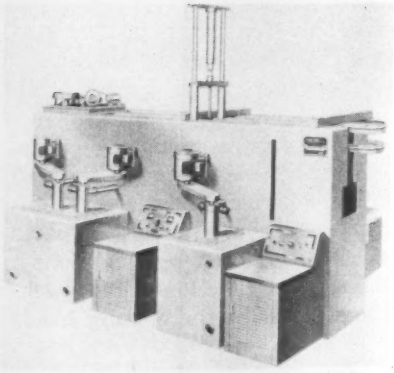
Sheet Imprinter & Coater

Designed to continuously imprint sheet zinc, aluminum, magnesium, steel, copper or plastic—with symbols, numbers, codes, trademarks or descriptions—sheet metal printer utilizes easily interchangeable rubber plates and compatible inks. Laminate coatings can also be layed on with the equipment, using precision turned rolls for the metered application of hot melts, adhesives, plastics, etc.



Normally, machine handles sheet 0.025 to 0.250-inch thick, 14 to 24 inches wide, and 34 to 42 inches long. Printing area is 13 inches wide, and is adaptable up to 72 inches. Printing speeds are adjustable up to 2800 sheets per hour, depending upon sheet size. Conveyor on infeed of the machine is constructed so as to prevent any possible scratching or damaging of sheets. **Industrial Marking Equipment Co. Inc.,** 454 Baltic St., Brooklyn 17, N.Y.

Circle 406 on Inquiry Card



Ultrasonic Cleaning

Automatic, five-stage monorail cleaning system combines a single ultrasonic cleaning stage with conventional wash, rinse and dry sections. Parts are carried through the machine on an automatic indexing double monorail conveyor. With the system, grease, lapping compounds, cutting oils, abrasives and other contaminants are quickly and easily removed from blind

holes and difficult recesses of castings, engine parts, stampings, valve bodies, etc.

In operation, the parts are loaded on fixtures traveling on the automatically indexing monorail conveyor. They move through wash, rinse, ultrasonic cleaning, rinse, and hot air drying stages. In the washing, rinsing and drying sections, the parts are subjected to sprayed wash or rinse solutions or to drying air. In the ultrasonic cleaning section, the parts are automatically lowered into the Bendix - manufactured ultrasonic tank where high-frequency sound waves break contamination loose from the metal parts.

Solution tanks and drying air are heated with electricity and are temperature controlled. The machine is placed in operation by pressing a single button; parts then proceed through the machine automatically, emerging thoroughly cleaned and dried. **Ransohoff** Inc., N. Fifth & Ford Blvd., Hamilton 9, O.

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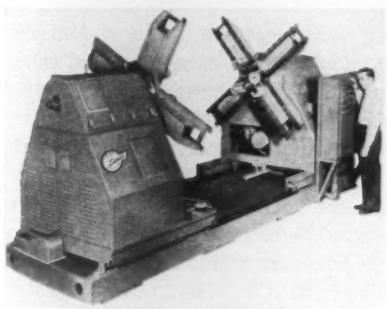

Coil Handler

Designed to handle coil weights up to 40,000 lb, Twin-In-Action unit handles steel, aluminum and even prepainted stock. Machine is comprised of standard components and is fully powered. The coil is picked up on the ID by four radially contoured power driven expander arms, eliminating the danger of damaging any portion of the coil. The four expander arms are operated in unison by positive power. Both reels are power driven and are synchronized to carry an equal part of the load.

Each reel can be laterally adjusted, independent of the other, or in unison — making it easier to establish a perfect alignment with

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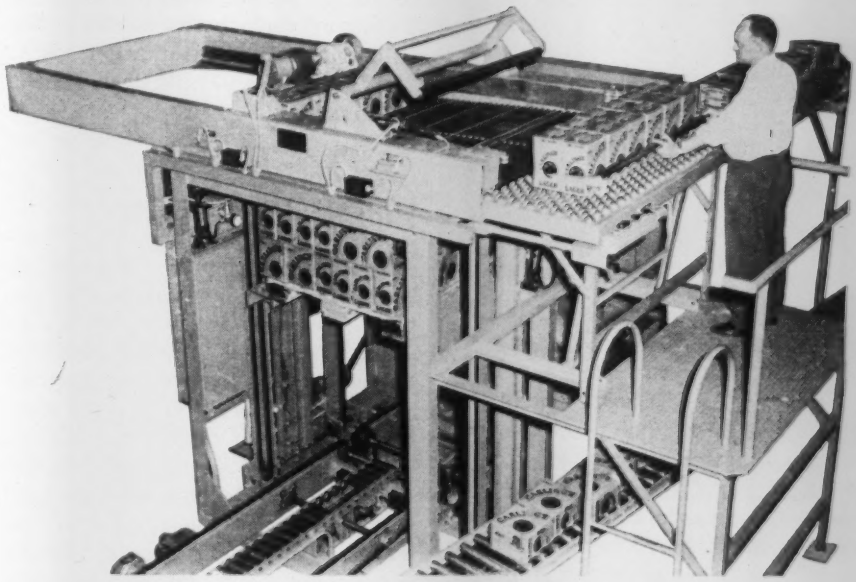

New Mathews Semi-Automatic Pallet Loader developed for the food and beverage industries.

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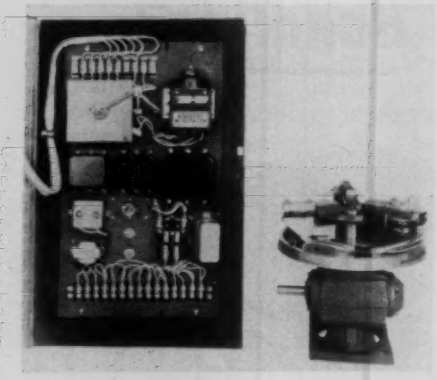
MATHEWS

Circle 584 on Inquiry Card

the press or die. Uncoiling of the stock is started by pressing a button. The stock flow is controlled by an electrically operated loop control, which also controls the pay-off. **Sesco Inc.,** 8881 Central Ave., Detroit 4, Mich.

Circle 408 on Inquiry Card



Magnetic Memory System

Designed for delayed control of high speed continuous process lines and automatic sorting of items moving through complex conveyor systems, magnetic memory system is designated Magdelay. Unit is used in continuous material processing lines such as sheet metal, wire, tubing, plastic, paper and textile, wherever automatic measurements can be employed to control subsequent operations. In warehousing operations and food processing plants, Magdelay is needed where automatic switching can be used to direct packages or items to two or more destinations.

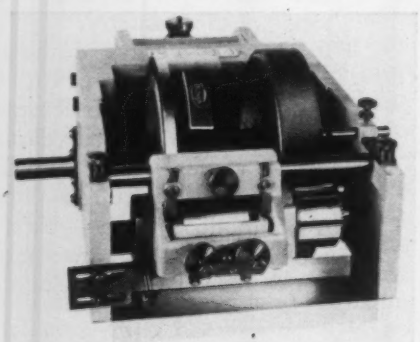
In these systems, the measurements to be remembered are used to magnetize narrow sectors of a hardened steel disk. The disk rotates in synchronism with the processing or conveyor line. The measurements are then read off the disk at the same time that the material that was measured reaches the action or sorting points. The readout is accomplished regardless of variations in line speed, and is unaffected by stopping and starting. After readout, the disk is erased and ready for reuse.

Magdelay systems accept signals from almost all measuring devices such as photoelectric controls, pressure switches, relays, beta gages, ultrasonic detectors, magnetic detectors, etc. Systems are insensitive to process or conveyor line speeds. No exact gearing of coupling ratio need be prescribed between the processing or conveyor line drive shaft and input shaft of the Magdelay. Long life is assured by the absence of physical contact between the magnetic heads and the memory disk. Any number of measurement stations may be added on a processing or conveyor line. Either one or two-action or sorting stations may be accommodated with Model 1000 (illustrated). **Automation Inc.,** 212 Worcester St., Wellesley Hills 82, Mass.

Circle 409 on Inquiry Card

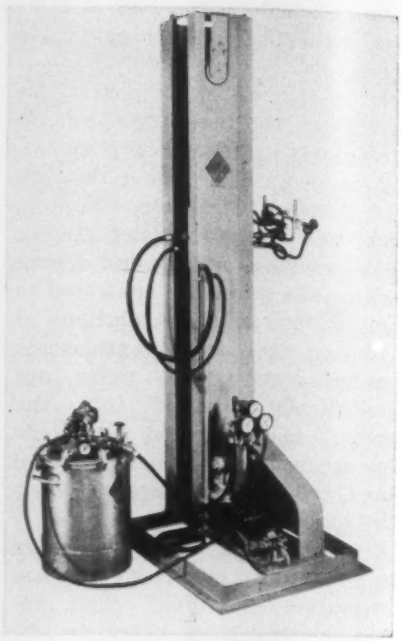
Plastic Pipe Printer

Company name, trademark, tradename, code numbers, etc. are printed on polyethylene, vinyl and other types of plastic pipe by Model 15AE roll printer. Imprint is made by precision molded rubber printing elements, sponge backed and mounted on curved steel plates. Tension springs hold the printing element on the die wheel, permitting quick simple changeover when imprint requirements change. Fast-drying marking compounds, available in numerous colors, provide clear, durable marking on several types of plastics.



In a typical installation, the roll printer is mounted on the extruding equipment, and pipe is imprinted before being coiled. Power to rotate the machine's die wheel is taken from the coiling equipment, although it may be driven from a separate motor if desired. Maximum imprint area is 1¾ by 24 inches, with imprint repetition every 24 inches or less. **Markem Machine Co.,** Keene 60, N. H.

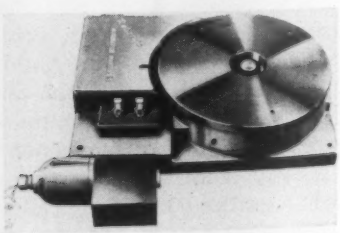
Circle 410 on Inquiry Card



Vertical Oscillator

Automatic spraying of panels, boards, strips or other flat pieces carried on overhead conveyors is possible with vertical oscillator unit. Automatic spray guns are carried up and down on a ball bearing carriage and are controlled by adjustable, cam operated valves to cut off spray at the end of each stroke. The explosion-proof motor with variable speed drive is adjustable to synchronize with conveyor speeds. Unit is supported on a heavy steel frame with a provision for permanent installation. **Paasche Airbrush Co., Div., Cline Electric Mfg. Co.,** 1909 W. Diversey Parkway, Chicago 14, Ill.

Circle 411 on Inquiry Card



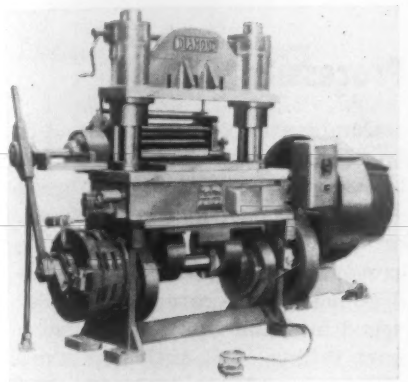
Index Fixture

Used for grinding, milling, broaching, boring, drilling, honing, checking, staking and assembling operations, compact index fixture is hydraulically operated and electrically controlled. Device can be synchronized with the automatic cycling of a machine; a limit

switch insures safety in operation. The table top is guaranteed flat and parallel within 0.0001-inch.

Unit has no gear, cams or mechanical pawls. The shot pin is held in place hydraulically for positive positioning of the table on any index from three to 120 degrees, and guaranteed to 0.0003-inch tolerance, without accumulation on a 12-inch gaging diameter. The fixture is operated with a four-way valve and solenoid with a spring return. The valve, which has a check valve and flow control, can be mounted either to the fixture or on the machine. **Automation Mfg. Corp.,** 8070 Wheeler Ave., Detroit 10, Mich.

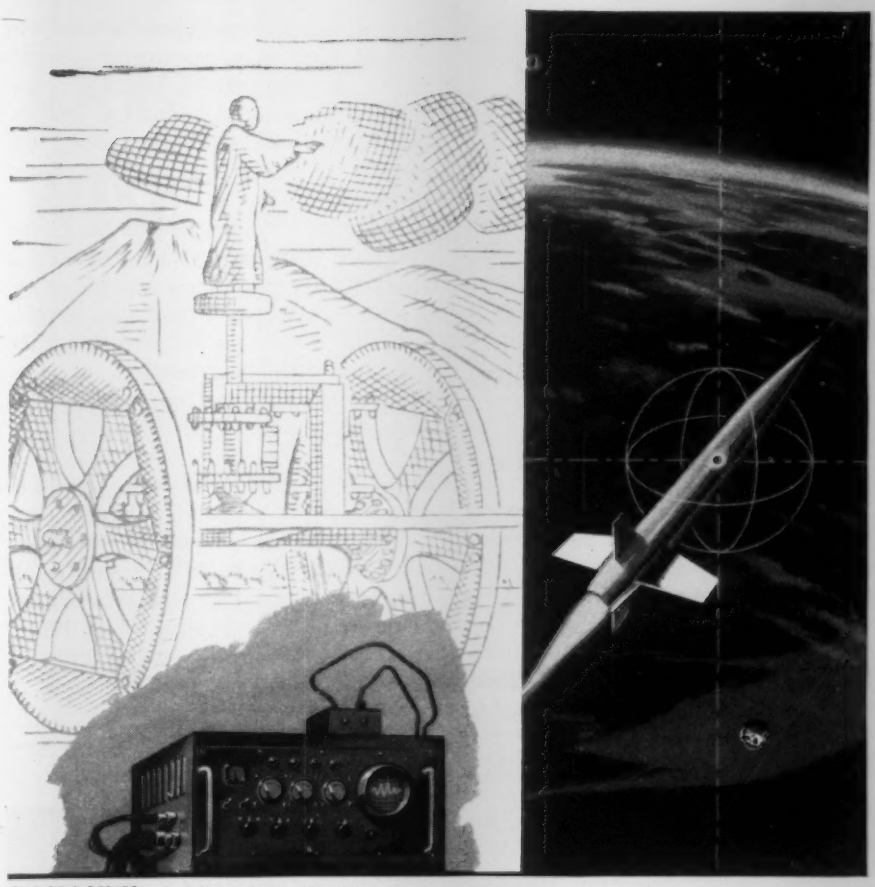
Circle 412 on Inquiry Card



Foil Stamping Press

Suitable for large quantity production of aluminum foil containers, 50-ton capacity Multi-Max punch press is designated Model 5024. A roll feed is mounted on the bolster plate to feed aluminum foil coil stock 24 inches wide. The roll feed has an advance from 0 to 14 inches. Press has a 5-inch stroke and operates at a variable speed from 60 to 125 strokes per minute. Eccentric weight counterbalance is installed on the underneath main shaft to counterbalance the weight of the ram. Open throat design on the press enables feeding with a roll feed from front to back. Low center of gravity with the underneath pull-down double cranks reduces normal ram deflection. Presses are single-geared, with a working surface of 10 by 24 inches and bed area of 16 by 24 inches. **Diamond Machine Tool Corp.,** 5111 Coffman-Pico Rd., Pico, Calif.

Circle 413 on Inquiry Card



ONE OF A SERIES—depicting guidance "Yesterday, Today and Tomorrow"

navigation is a problem

From the ancient Chinese comes one of the earliest known directional devices. Not the magnetic compass of legend, but a mechanical compass with differential gears for maintaining a constant south-pointing position. It was used by Yellow Emperor Hunag Ti about 2634 B. C. to guide his armies across the vast steppes leading to the sunny, fertile lands of the south.

Many forms of navigation have been developed since, each system requiring greater scientific knowledge. One of today's systems is inertial guidance, a complex integration of electronics and servo mechanisms utilizing the best that present technology can provide.

At Bell, problems in navigation or guidance have been answered in many ways . . . missile guidance systems . . . a recovery system used in several missiles . . . and a landing system for aircraft in all types of weather.

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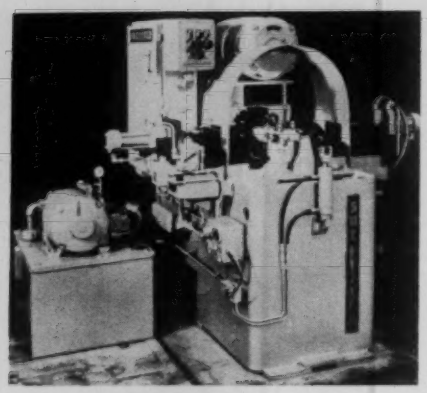
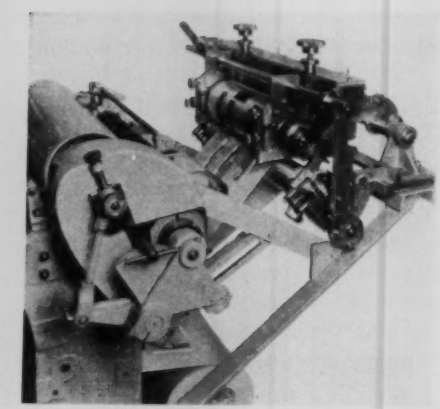


Thread Rolling Machine

Both right and left hand threads can be rolled on bicycle cranks in a single, automatic cycle on new machine which operates at a rate of approximately 120 parts per hour including load and unload time. Machine consists of a floor-type base on which are mounted two Precision-Rol units operated by a hydraulic subslide assembly.

In operation, the crank is loaded between centers and clamped in the work holding fixture. The operator then pushes a button to actuate an oversize Precision-Rol to roll the 15/16-inch-24 right hand thread. After the unit retracts, the standard Precision-Rol attachment comes into position for rolling the 7/8-inch-24 left hand thread to complete the automatic cycle. The right hand thread rolls are extra large to clear the driving lug on the bicycle crank. **Sheffield Corp.,** Dayton 1, O.

Circle 414 on Inquiry Card

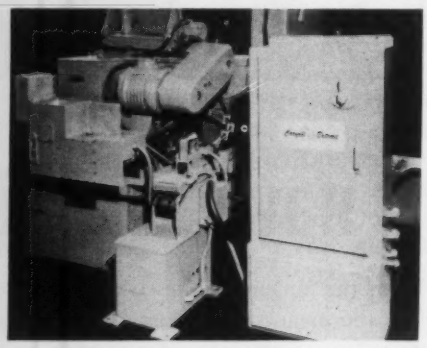


Imprinting Attachment

Designed for simple installation on any standard wrapping or bundling machine, compact attachment imprints any changeable legend on the wrapper as an integral part of a packaging operation. Attachment is used for applying code dates, flavors, colors and other supplementary copy on wraps of cellophane, other films and paper.

Imprinter incorporates a flexographic printing system that uses fast-drying liquid inks of any color. Units are available which provide for either random imprints or accurate registration of imprints in any desired location on the package. Operation of the unit is completely automatic and can be synchronized with the parent machine at any standard production speed. Available in various sizes to produce imprints up to 24 inches wide, the attachment can be quickly changed for different cut-off or repeat lengths. **Adolph Gottscho Inc.,** Hillside 5, N.J.

Circle 415 on Inquiry Card

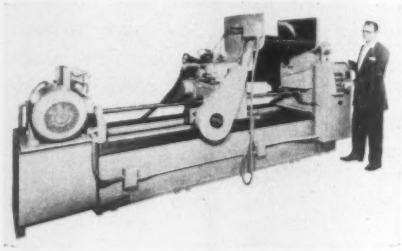


Automatic Size Control

Increased accuracy in stock removal operations is achieved with continuous proportional automatic size control. Basically, the control consists of a transducer gaging head, amplifier, and servodriven transmission. As illustrated, parts coming from the machine are fed through the gaging head by an auxiliary feed mechanism. For multiple machine throughfeed applications, the gage head is mounted in line on the parts conveyor. An optional size sorting mechanism directs the sized parts to different chutes.

Illustrated is a centerless rough grinding operation on a bearing race OD. With an average stock removal of 0.010, part size is held within the irreducible machine scatter, ±0.0002. Control method eliminates the saw tooth pattern (graphically recorded) inherent with the use of jogging controls. Unit measures every piece, and the setting of the operating machine is influenced by the size deviation of each part. Thus, adjustments are continuous and are never large. **Cargill Detroit Corp.,** 2254 Cole Ave., Birmingham, Mich.

Circle 416 on Inquiry Card

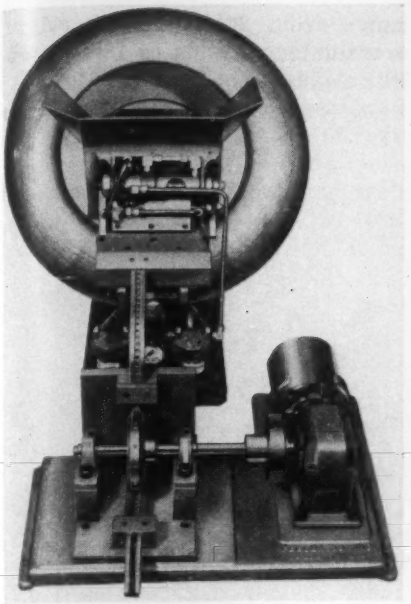


Processing Tubing

Combination de-denting and deburring machine makes it possible to remove the dent caused by cut-offs and to burr as well as chamfer or face both ends of a tube simultaneously. Mechanically and hydraulically operated, the high-speed machine can de-dent and deburr tubing of ¼-inch to 1 inch in diameter and 1½ inches to 10 ft in length at rates in excess of 3000 pieces per hour.

Machine can quickly change from one size tube to another by removal of four screws to replace the clamps with the desired tube size. Clamps are keyed to position and clamping pressure is easily adjusted by nut on the toggle. The movable head is quickly adjusted by pushbutton control of the worm gear reducer attached to the head and operating on rack and pinion arrangement. Bin loaded parts are automatically fed to the clamping mechanism for work, then automatically ejected. Tubes in the bin are agitated by a cam arrangement on the heads. Two ½-hp variable speed drives with 8.0 to 1.0 ratios power the spindles. Main shaft is driven by a 1 hp variable speed drive with infinite adjustment. Because of its stability, the machine can also be used for high speed centering. **Tubco Industries Inc.,** 14211 Manhattan, Oak Park, Mich.

Circle 417 on Inquiry Card



Clinch Nut Hoppers

Available as a complete system with hopper, track and gravity feed, or hopper and tracks with power feed, standard rotary hoppers automatically feed clinch nuts. Units are available in two basic hopper sizes: 18 and 24 inches, equipped with either gravity or power feed. One or two tracks can be used on the 18-inch hopper, and up to four tracks can be used on the 24-inch hopper. Rated output per track ranges from 150 to 250 pieces per minute.

Feeding system operates on a fully enclosed, continuous duty motor, equipped with a slip clutch for overloads. Gears are mounted on ball bearing shafts throughout for heavy duty service. All gears and bearings operate in an oil bath. Hopper has a three-point mounting for easy installation on rough or uneven surfaces. **Feedmatic-Detroit Inc.**, 26901 W. Seven Mile Rd., Detroit 19, Mich.

Circle 418 on Inquiry Card

Pan Type Conveyor

Used for conveying heavy items such as spiral metal turnings, stampings, castings, forgings, etc., pan-link conveyor features simple construction. No conventional chain is included in the design. Flat side skirts serve as links, insuring correct pitch and also serving as sides to contain conveyed materials. Another feature is the

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TAPE-CONTROLLED AUTOMATIC POSITIONING TABLE

Check These Features...

- No stops
- No gauge rods
- Only SECONDS to change tapes
- MINUTES to set up
- No more than 11 tape holes to punch per position
- 600,000,000 possible positions. Hundreds of positions per single set-up
- Automatic magnetic locking
- Accuracy — plus or minus .001"
- Unidirectional approach at minimum speed
- Simultaneous operation of both coordinates

The 20"x30" ARTER has them all

ARTER GRINDING MACHINE COMPANY

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Flat Circular Cutter Grinders • Internal Grinders • Cylindrical Grinders • Carbide Tool Grinders

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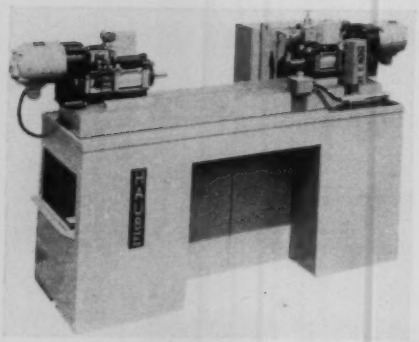
mounting of wheels on an axle rod which passes through a set of double bushings. Smaller diameter inner bushings are welded to the rear edge of leading apron pan, while larger diameter outer bushings at both sides are welded to the leading edge of the following pan.

Construction is advantageous when carrying abrasive materials, since it eliminates the abrasion and rapid wearing of one pan edge against another. Coolant fluids can also drain out between pans. Conveyor housing is a girder-like box section, with two pairs of longitudinal rails on which the loaded and return aprons roll. Modular conveyor sections are built in standard 10-ft lengths for assembly to any length required. Apron design is flexible, permitting conveyors with one drive unit to operate horizontally, with ascending or descending sections. **Hapman Conveyors Inc.,** Kalamazoo, Mich.

Circle 419 on Inquiry Card

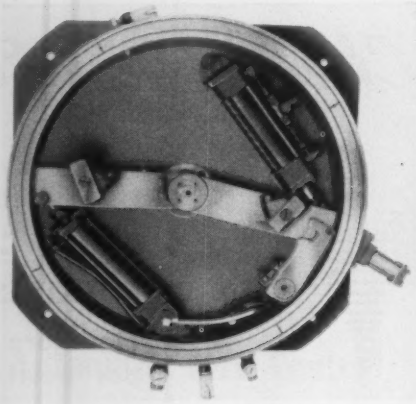


Double End Machines

Designed to perform special machine type operations such as drilling, tapping and other end-cutting functions, double end machines incorporate two Model 24 Holomatic drill units, a steel weldment base and complete air and electric power and cycle control systems. Built-in cycle control systems are of universal design and provisions are made for interlocking the operation of automatic devices such as air clamps, index tables, part feeders, etc. with the drill units.

Holomatic units are flexible tool feeding devices using shop air line pressures for thrust, and self-contained sealed hydraulic systems for spindle travel control. Rapid travel movements, feed rates and stroke lengths are all adjustable in both the advance and retract motions. The maximum stroke length per unit is 4 inches and the maximum work capacity is 2 hp. Spindle speeds from 190 to 10,000 rpm are available. **Hause Engineering,** Montpelier, O.

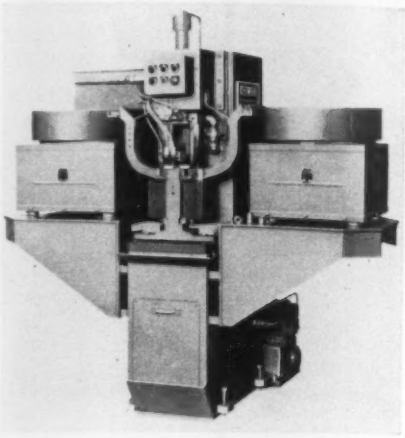
Circle 420 on Inquiry Card



Rotary Indexing Table

Designed to handle loads up to 500 lb, 26-inch heavy duty, air operated rotary indexing table features a design which avoids any chance of overindexing. An adjustable hydraulic control assures cushioned stops under all load conditions. Splash lubricating system permits all hardened moving parts to be fitted to close tolerances, providing indexing to ± 0.0005. Two limit switches are mounted on the outside of the table for quick and easy adjustment. Setup work is simplified by a double solenoid valve equipped with pushbuttons for rapid changeover from automatic to manual operation. Operating pressures range from 75 to 100 lb. Unit is available with six to 18 stations. **Pitt Industries,** Carnegie, Pa.

Circle 421 on Inquiry Card

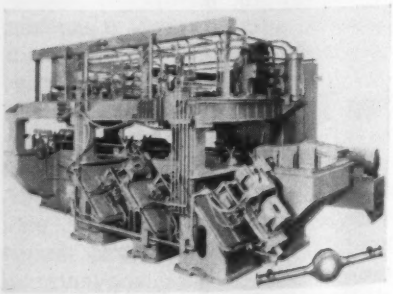


Broaching Press

Radius groove is broached in both ends of two different length pinion gear blanks at the rate of 2080 pieces per hour by hydraulic broaching press. Operation is fully automatic, requiring no operator. Blanks are loaded into hoppers on each side of the machine, positioned and loaded into feed magazines by vibration, pushed through stationary broaches by twin pushers attached to the hydraulic press ram, and unloaded automatically into ejection chutes.

Hopper loading can be done automatically; the machine will stop if the hoppers are empty. Electrical and hydraulic systems are entirely self-contained. Compact machine is 4 ft deep by 5 ft high by 9 ft wide. **Detroit Broach & Machine Co.,** Dept. 106, Rochester, Mich.

Circle 422 on Inquiry Card



Housing Processor

Called the Line-O-Matic, machine is designed to be mounted

into a processing line and perform its series of operations automatically. The machine processes rear axle housings for both passenger cars and trucks. Any one of three different housings can be processed with no additional locators required.

The unit handles a welded assembly on which there has been no previous machining. It automatically pierces, extrudes, machines, assembles, loads and unloads. When the part is automatically loaded into the machine from the conveyor line, it trips a limit switch, which in turn initiates the cycle of the machine. The part is shuttled to the next station and lifted into the fixture, after which the shuttle returns. The part is located up and down from four points on the banjo face. The endwise location is taken from four points inside the banjo. Angular location, as well as up and down clamping, is taken just outside the banjo on the tube. All locating surfaces are dirt and chip free because the locating surfaces are upside down.

At the first workstation, drawing compound is automatically applied and the drain hole is hydraulically pierced and extruded. The drain hole is tapped for a $\frac{3}{8}$-inch piping plug and the vent hole is drilled for a $\frac{1}{4}$-inch pipe plug at the second station. At the next workstation, Permatex is applied to the drain hole and both sides of the vent hole are deburred. The machine automatically feeds and runs the $\frac{3}{8}$-inch pipe plug into the drain hole at fourth station. In addition, the vent hole is tapped for a $\frac{1}{4}$-inch pipe plug. Finally, at the last station, the rear axle housing is turned over and unloaded onto the conveyor line. **LaSalle Tool Inc.,** 3840 E. Outer Dr., Detroit 34, Mich.

Circle 423 on Inquiry Card

Electronic Printer

Magnetic core memory storage which reduces number of tubes to less than 300 has been added to high speed electronic printer. Printing speeds have been stepped up so that the printer can print up to 36,000 characters per minute of alphanumerical data and 72,000 impressions per minute of strictly

PANELSCOPE

by Waterman

FOR AUTOMATIC PORTRAYAL

SIZE:
5-1/4" x 5-3/16" x 10"
5 Pounds

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The Waterman PANELSCOPE is a custom-built cathode ray tube oscilloscope, with simplified operation, and yet available at a low price. The PANELSCOPE concept provides for the following:

- MINIATURIZATION — Panel space required is only 5¼" x 5-3/16" — depth is 10" and the weight is less than 5 lbs. The PANELSCOPE can be installed in practically any equipment — mobile or stationary air, sea, or land — military or commercial.
- SIMPLICITY OF OPERATION — Twist of a single rotary switch provides a synchronized pattern of desired incoming signal (up to 11 circuits) against proper linear time base. This is ideal for monitoring and trouble shooting, as it removes the need of fiddling with knobs as it is done now on general purpose oscilloscopes. The static controls, such as beam, focus, positioning, and graticule brightness are located in tube escutcheon.
- CUSTOM DESIGN — A wide variety of — signal amplifiers with response from dc to megacycles and sensitivities from 5 millivolts — synchronized or triggered linear time base generators from ½-cycle (and lower if need be) to 2 microseconds — can be specified by you to fit your needs for particular equipment.
- PARTIAL KIT FORM — The PANELSCOPE comes fully wired and tested with chosen signal amplifier, linear time base generator and attendant sync. amplifier. The desired signal attenuators, frequency and amplitude determining components, and method of synchronization can be installed either by us or by you.
- POWER REQUIREMENT — Less than 10 watts of line power for built-in high voltage supply — The required B+ and heater current as selected by your requirements. For those cases where B+ and heater power is not available, auxiliary power pack can be supplied.

There is a place in your equipment for Waterman PANELSCOPE, a custom built oscilloscope at production prices, although your needs may be but one or two. May we have your requirements?

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S-12-C SYSTEMS RAKSCOPE*
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S-14-C COMPUTER POCKETSCOPE*
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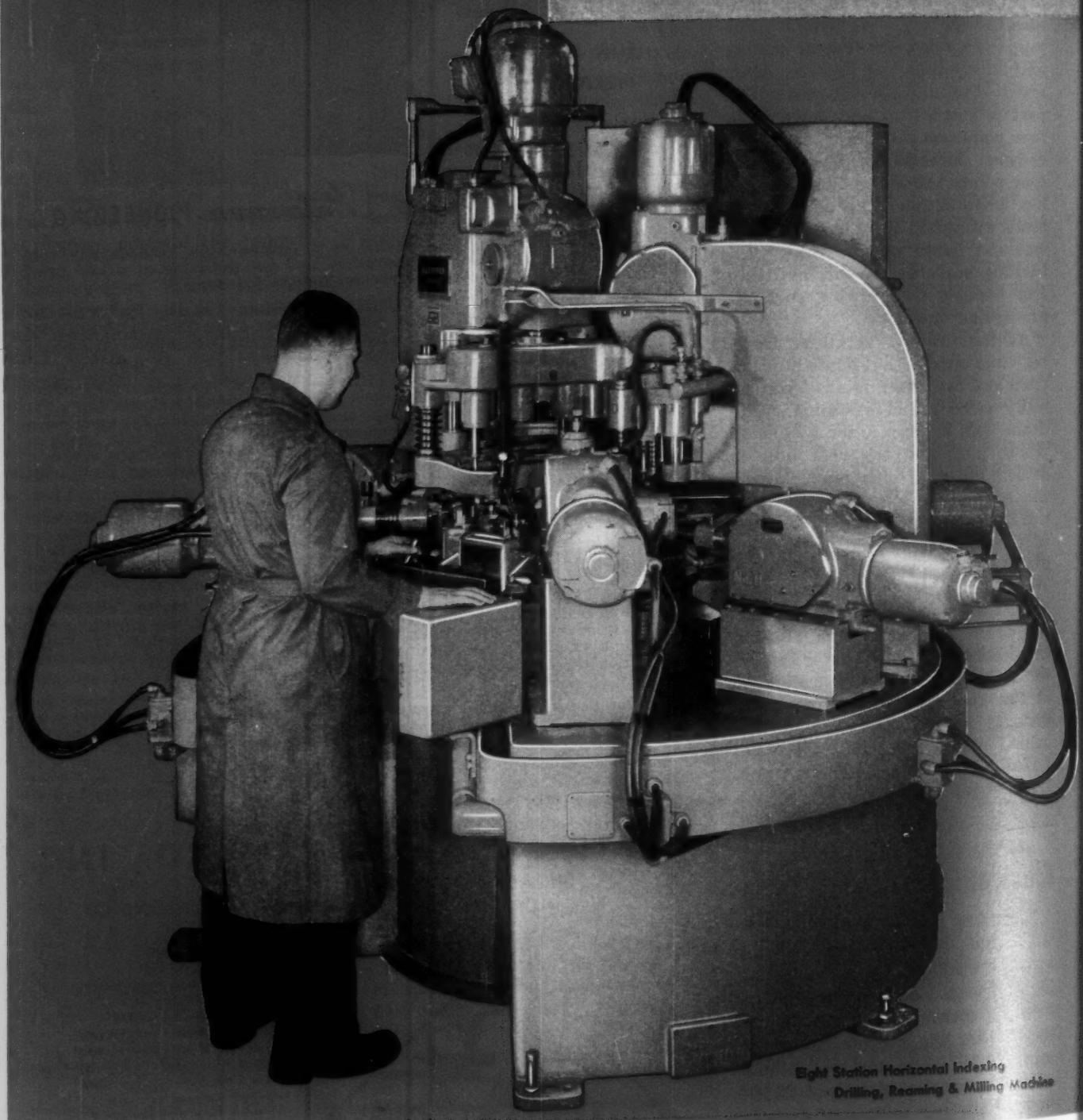
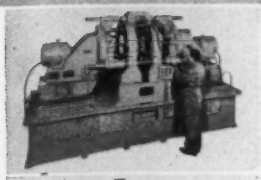


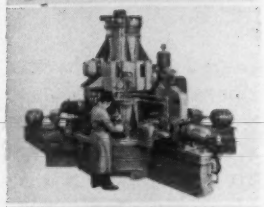
Eight Station Horizontal Indexing Drilling, Reaming & Milling Machine

ONE SOURCE FOR BOTH

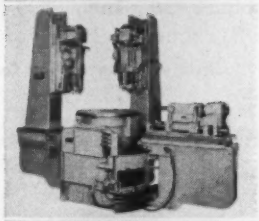
Automatic Production Machines



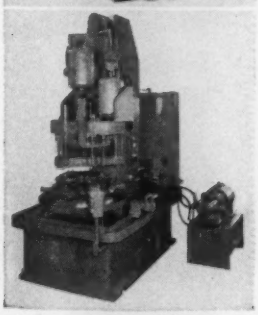
Double End Trunnion Type Machine



Center Column Indexing Type Machine

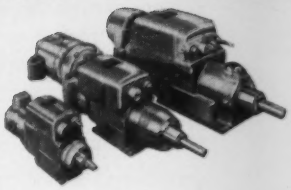


Universal Drilling Machine for jet aircraft components

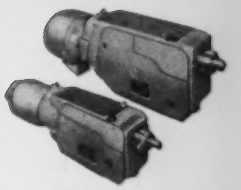


Vertical Single Unit Multiple Spindle Indexing Machine

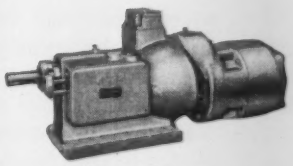
Standard Machine Components



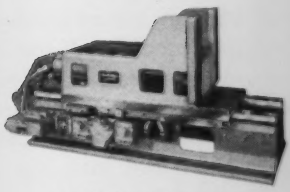
Quill Type Air Hydraulic Drill Units



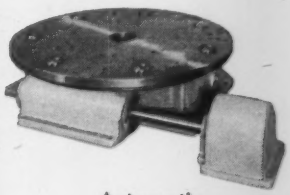
Quill Type Cam Units



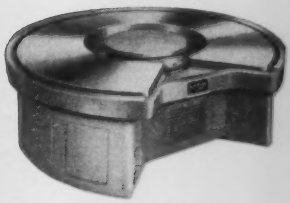
Quill Type Lead Screw Tapping Units



Way Type Hydraulic Feed Units



Automatic Index Tables Horizontal and Vertical



Machine Bases

Designing and building automatic production machines like those illustrated are a "Hartford" specialty. Years of experience have proven that dependable high production and economy can best be brought to the user by means of standard machine components.

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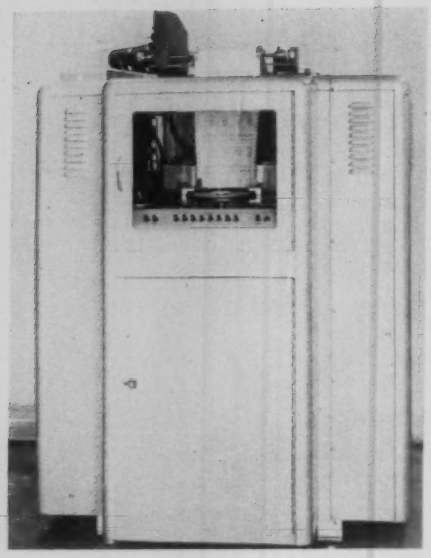
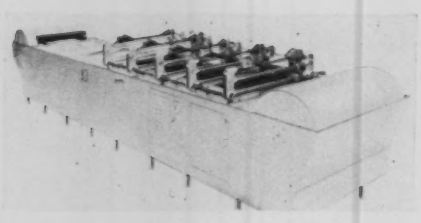


numerical characters. Printer is supplied with 51 characters per print-wheel font. These include 26 letters of the alphabet, 0 to 9 numerals, and 15 special characters such as #, &, etc. Unit consists of the printer, magnetic storage and power supply cabinets and magnetic tape handler. Tape handler is included, since to fully utilize speed capabilities of printer a high speed input source is necessary. Data can be fed into the printer from punched or perforated tape handlers or directly from a high speed digital computer. Printer is primarily intended for use where high speed printing of extensive data is required. Common business applications include production schedules, sales records, etc. Scientific applications would include tabulation of measurement data, and ballistics tables. **Potter Instrument Co. Inc.,** 115 Cutter Mill Rd., Great Neck, N. Y.

Circle 424 on Inquiry Card



Silk Screen Press

Operating on a conveyor principle, multicolor silk screen press features an automatic stop motion which can be set to permit the movement of the carrier platforms in single or multiple order over the color screens. This stop action also insures hairline registration.

Printing of cloth or other porous material is made practicable when the automatic stop motion is set for single order movement. For paper or other hard substance printing, the drying factor (built-in infrared oven) must be utilized after one color is printed and before the next color is applied. The automatic stop motion feature is preset to work in the desired multiple movement in order to facilitate screening on these materials. Automatic two - way squeegee action which can be adjusted to light or heavy pressure, according to the job requirements, works in conjunction with the platform movement order.

By using the conveyor system, additional work units can be placed upon the conveyor to receive the first color. When all the platforms have passed through the color screens and dried, every fourth unit will be a finished one and can be removed and replaced by a new work unit for the first color printing.

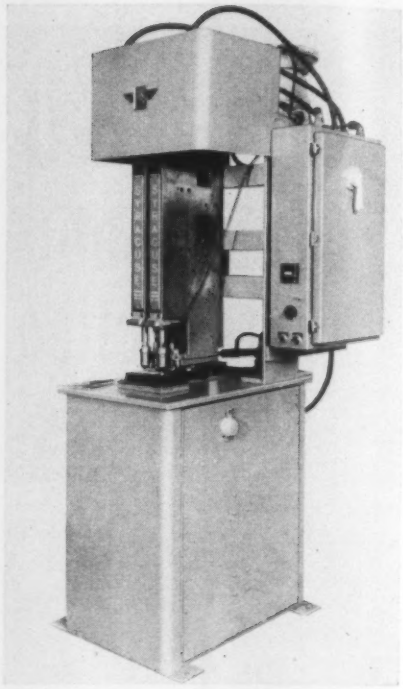
Entire operation is controlled through the use of pneumatic power and is adaptable for use on any screenable surface from tissue-thin paper up to 6-inch thicknesses. Under normal operating conditions, the press will produce from 300 to 650 four-color prints per hour. **American Automation Inc.,** 175 W. Jackson Blvd., Chicago 4, Ill.

Circle 425 on Inquiry Card

Automatic Stud Driver

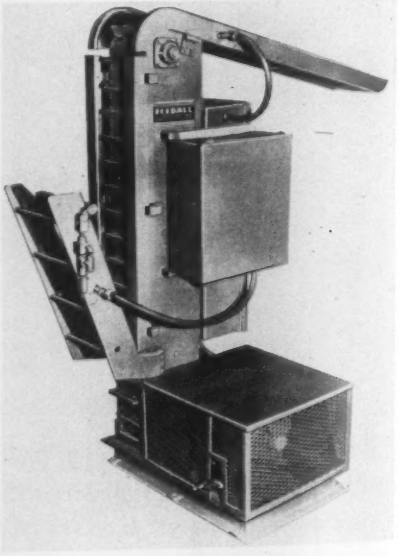
Designed to meet the demand for a smaller version of the six-head and 12-head automatic stud drivers, Model SD10-2 unit is easily adaptable to from one to three heads. Heads can be changed to a new pattern quickly, using spacer bars. Since the heads can be spaced as closely as 2½ inches center to center, they are easily integrated into automated index tables or conveyor lines.

Heads are individually driven by ½-hp motors, ac or dc, or air torque, and are fitted with airdraulic or hydraulic connections. Units are equipped with an electrical cabinet, vibratory four-track stud hopper, and either airdraulic



or self-contained electric-hydraulic unit. Self-operating chucks, which are positive in drive, grip and release the studs without screwing out the driven studs. **Syracuse Special Machine Co., Inc.,** 2900 E. Erie Blvd., Syracuse 3, N.Y.

Circle 426 on Inquiry Card



Elevating Transfer Unit

Designed to transfer long cylindrical parts from one production machine to another, Model 4000 elevating transfer conveyor accepts parts in a rolling position from the discharge chute of the first machine, elevates them and delivers them to the magazine of

the next production machine. Conveyor operates at a delivery rate adjusted to that of the second production machine and is equipped with a bank control which shuts off the first machine if it is feeding faster than the second machine can handle parts.

Model 4000 handles cylindrical parts from 3/8 to 1¼ inches in diameter and up to 12 inches long. Power is furnished by a ¼-hp, 220/440v motor through a variable speed drive. **Feedall Inc.,** Willoughby, O.

Circle 427 on Inquiry Card

Gear Gaging & Sorting

Featuring compact, standardized design for a wide range of gear sizes, Model GRD automatic gear gaging, sorting and machine tool control unit can be adapted to the checking of individual spur or helical gears up to 3 inches in diameter and 3 inches wide. Machine is available in types that will check and sort production gears for both size and helix angle accuracy, or size or helix angle only. Machine will shut down gear production machine tools automatically after a specified amount of rejects of a specific type are gaged. Indicator lights tell the type of reject which caused the machine shutdown.

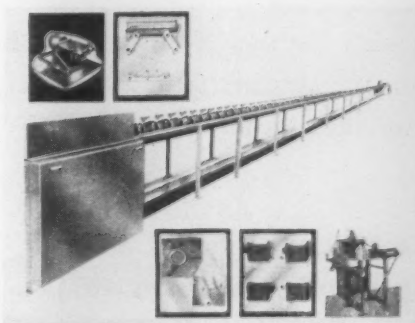
Complete gaging machine consists of a motorized gaging and sorting unit through which the gears are fed one at a time automatically from an inclined feed chute, a stand that supports the gaging unit and reject pans, a separate electrical panel and an individual pushbutton and indicator light control box. The panel and control box can be mounted either near the machine or at some remote location.

Illustrated machine checks 1-inch diameter, 5/8-inch wide, 18-pitch helical pinions. Gaging unit is an iron casting having the master gear gaging unit and indicator mechanism mounted on one side of a vertical face and enclosed with a hinged cover. Electrical terminal strips, solenoids and motor drive are on the opposite side of the vertical face. **National Broach & Machine Co.,** 5600 St. Jean Ave., Detroit 13, Mich.

Circle 428 on Inquiry Card

Platen Conveyor

Designed for precise synchronization for integrated operations and completely adaptable to automation lines, expansible platen conveyor is used for assembly, inspection and other processing. Conveyor features jig drilled interchangeable 10-ft sections; 36, 38 or 40-inch working heights; 12-inch long steel platens, each providing 12½ inch wide working area; 4000-lb chain pull; continuous variable speed range from 100 to 300 ft per hour; overload cut-out clutch; lubricated ways and bearings; start-stop-reverse pushbutton control panel; right or left hand offset drive, as specified; parts-pan support rail; and stationary or index



fixtures. Optional features available are: In-line or vertical drive; automatic lubrication; intermittent or index motion; special speed ranges; platens in specified sizes; specified lengths, heights, widths and speed ranges; arrangements for automatic indexing of fixtures; clamping and unclamping of parts, plus loading and unloading devices of all types. Standard conveyor model is available in lengths up to 100 ft. **Visi-trol Engineering Co.,** 9345 Hubbell, Detroit 28, Mich.

Circle 429 on Inquiry Card

Instrument Systems

ENGINEERING

Qualified engineers and designers — Electrical, Chemical, Mechanical — experienced in instrumentation design for the petroleum and petrochemicals industry, can broaden their professional responsibilities in our Chemical Engineering Department.

Assignments include the application of automatic control principles to a variety of plants from complete integrated refineries and chemical processing centers to individual process units of all types. Work includes engineering of instrument systems, the selection, specification, and inspection of components, and startup of completed plants.

Top salaries, fine facilities, profit - sharing retirement plan. Write to the head of our Personnel Department, Mr F B Stratford.

C F BRAUN & CO

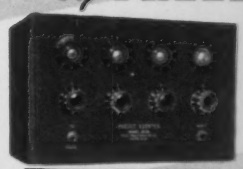
ALHAMBRA CALIFORNIA

Engineers

Consultants Constructors

Circle 589 on Inquiry Card

New **PRESET COUNTER** *by* **FREED**



MODEL 2020

The Freed Model 2020 Preset Counter is designed for low cost reliable counting applications, where accuracy and maintenance-free operation is required.

Cold cathode counting and trigger tubes, with simplified circuits, are used throughout which assure years of trouble-free counting service and low-power consumption.

Model 2020 is a 4-digit single preset counter capable of controlling any operation that is repeated up to 9,999 times. Any number from 1 to 9,999 may be preset on the 4-digit selector switches. When the preset total has been reached, the counter will provide an output pulse and close contacts on a relay. These outputs may be used simultaneously or separately to stop machines, actuate control signals, or trigger additional equipment.

SPECIFICATIONS

Maximum Count: Four digits — 9,999	Pulse output 50 volts
Maximum counting rate: 300,000 counts per minute	**Size:** 8 x 6 x 12 inches
Input Sensitivity and Waveform: Not critical	**Weight:** 11 pounds
Outputs: Relay contact 10 Amperes	**Power:** 25 watts 105-125 volts, 50-60 cycles
	Price: $425.00

Freed also manufactures Totalizing, Preset, and Batching Counters

SEND FOR COMPLETE INFORMATION

Engineering assistance available for adapting these counters to your specific applications.

FREED TRANSFORMER CO., INC.

1705 Weirfield Street

Brooklyn (Ridgewood) 27, N. Y.

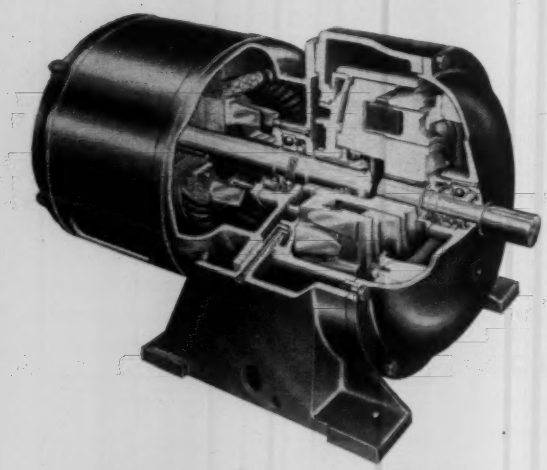
Circle 590 on Inquiry Card

No Commutators, No Rings, No Brushes, No Rotating Coils—in the NEW

EATON

DYNAMATIC®

Adjustable Speed Drives



Dynaspede® Stationary Field Coupling, with Integral Motor

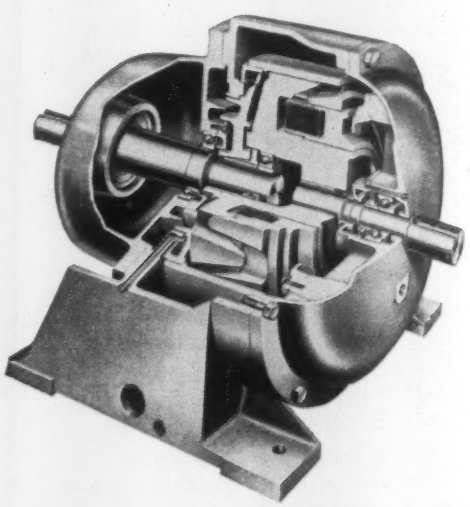
Dynamatic stationary field couplings are the simplest drives so far devised to provide infinitely adjustable speed from an alternating current source. The absence of rotating coils, brushes, slip rings, and commutators in this design holds wear and maintenance to an absolute minimum. Dynamatic electronic or magnetic amplifier controls, in combination with these drives, provide wide latitude in operating functions.

Check these Outstanding Advantages:

Accurate speed control • Wide speed range • Low power losses • Simple construction • Rapid response • Remote control • Quiet, efficient operation • Low maintenance costs

Ajusto-Spede® Drives: Air cooled, stationary field eddy-current couplings mounted integrally with D-flange open drip proof squirrel cage motors are available in capacities from 1 to 75 HP. Units of the same design and capacities are also available without motors.

Dynaspede® Drives: Liquid cooled, stationary field couplings mounted integrally with D-flange squirrel cage motors are available in capacities from 3 to 75 HP. Motor types available are drip proof, splash proof, totally enclosed fan cooled, and explosion proof. The coupling is totally enclosed. Separately mounted couplings are also available in capacities from 3 to 2500 HP and larger.



Stationary Field Coupling for use with Separately Mounted Motor

Send for Detailed Information on these New Stationary Field Couplings and Drives

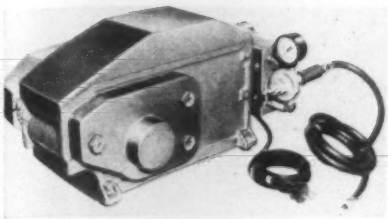
EATON MANUFACTURING COMPANY
DYNAMATIC DIVISION
3307 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

Circle 591 on Inquiry Card

AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems

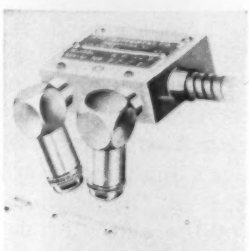
For detailed information and literature, use card page 17



Tape Dispensers

Four models are included in series of fully automatic, air-operated tape dispensers which eliminate all pushbuttons, levers and foot pedals. When the operator removes a length of tape, a limit switch automatically sets in motion the next delivery cycle. Units are available for all types of pressure sensitive tape in widths up to 4 inches and lengths to 21 inches. Materials on which Model AFET-822 (illustrated) is used include filament, glass fiber, cloth, heavy paper, plastic film, cellulose, acetate fiber tapes, etc. **Air Fixtures Inc.**, 202 W. Main St., N. Manchester, Ind.

Circle 430 on Inquiry Card

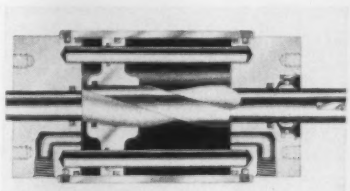


Photoelectric Relays

Designed to provide a compact, self-contained adjustable pickup for use with other ESS controls and counters, Model RFU-7 reflecting type relays are used in inspecting, sorting, counting and control applications where the difference in reflected light differentiates acceptable and reject conditions. Relays are widely used in packaging, printing, assembling machines, etc.

Position of the light source and photounit is adjustable as to angle and reflection of spot distance. IRC series relays contain the controls for adjusting the light intensity and also the photounit sensitivity. With these controls, the relay can be triggered to act at any desired threshold of reflected light. **ESS Instrument Co.**, 96 S. Washington Ave., Bergenfield, N.J.

Circle 431 on Inquiry Card



Rotary Actuators

Used for indexing, positioning, transfer mechanism, valve actuating, ratchets, gate opening, dumping, cam actions, mixing, power takeoffs, tumbling, automatic conveyor stops, breech locking, rolling, clamping and lifting, rotary actuator features full 360-degree rotation and positive stopping at any position. Device is a self-contained power unit designed to operate on air, gas, water or oil pressure. It delivers a fast and positive rotary motion by means of a piston and simple internal helix.

There is no bypass leakage or pressure loss, and because of the internal helix, the work load is firmly held in position and cannot back off under reverse tension, shock or vibration, even if a complete power loss occurs. Through use of antifriction thrust bearings, it is possible to operate the actuator on presures from 5 to 500 psi. Actuator is available with built-in valving or with attached pump, motor and reservoir, or all of the foregoing. **Carter Controls Inc.**, 2800 Bernice Rd., Lansing, Ill.

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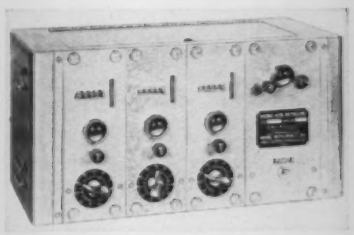
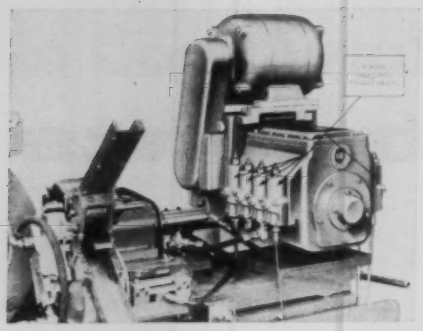


Hole Detector

Quality control device, called the Void Detector, is designed for the detection of minute or large holes in any material which is electrically nonconducting. Standard model tests materials such as paper, plastic and rubber up to 0.025-inch thick and records holes 1/64-inch in diameter and larger. Detecting and recording system includes the use of a one, two or three-position indicator unit connected electrically to feeler brushes.

Feeler brushes are attached to the roll, plate or bar which is processing the dielectric material. Whenever a void in the material passes between the feeler brush and the grounded roll, plate or bar, a low voltage pulse is transmitted to the indicator unit where it is measured and recorded. A sensitivity adjustment permits the differentiation between hole sizes to be detected. Two and three-position instruments not only record all holes and count them, but also indicate the sections in which the holes appear. **Viking Instruments Inc.**, East Haddam, Conn.

Circle 433 on Inquiry Card

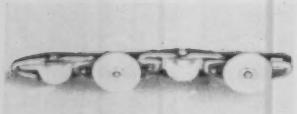


Compact Controller

Used for multiple circuit hydraulic power and sequence control, Hydra-Cam consists of a series of hydraulic power cylinders, each connected to an individual closed hydraulic circuit. Each cylinder is equipped with a power piston driven by one of a series of cams mounted on a common shaft. The cam shaft is powered through a two-speed transmission.

By varying the characteristics of the individual cams, any timing and sequence or overlapping of motions is obtainable, as well as any length of stroke within power cylinder limitations. Feeds, chucking, clamping, loading, unloading, gaging, etc. are some of the functions available for boring, broaching, grinding, milling, drilling, welding assembly and other machines which combine two or more operations in timed relationship. Any type motion can be produced, such as constant velocity or harmonic. Cycles can be as fast as one per second. Two-speed drive provides for both the work and idle cycles. **Earl A. Thompson Mfg. Co.,** 1300 Hilton Rd., Ferndale, Mich.

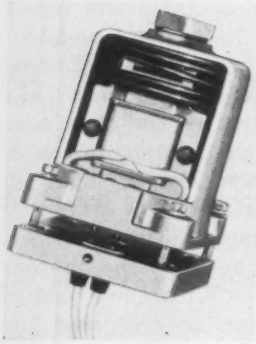
Circle 434 on Inquiry Card



Nylon Wheel Chain

Used for a variety of materials handling operations, overhead conveyor chain combines nylon wheels and stainless steel bearings. Nylon wheels running fully enclosed on steel track provide quiet operation. Where moisture is a problem, stainless steel bearings and the nylon wheels eliminate bearing corrosion. Because no lubrication is needed on the bearings, nylon wheel chain is ideal for food handling operations. Chain is resistant to most common organic solvents, alkalis and most organic acids. **Materials Handling Div., Richards-Wilcox Mfg. Co.,** 438 W. Third St., Aurora, Ill.

Circle 435 on Inquiry Card



Oil Immersed Solenoid

Long life and good performance characteristics are features of solenoid which is oil immersed and individually sealed to avoid difficulties of contamination of the immersion oil by sludge and destructive foreign materials.

Sealed unit is equipped with plug-in contacts and is easily installed. It is securely anchored in working position by four captive bolts. Manual operation of the solenoid for machine setup is accomplished by means of a sealed pin in the case top. Solenoid is shock mounted in two directions and operates 35 to 50 degrees cooler than standard models. **Detroit Coil Co.,** 2435 Hilton Rd., Ferndale, Mich.

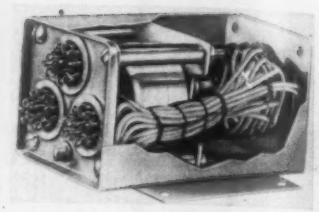
Circle 436 on Inquiry Card

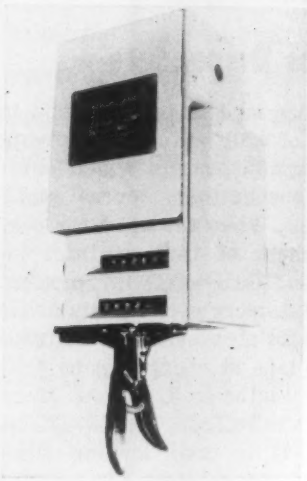
Sealed Relays

Applicable in the aircraft, automation and electronics fields, hermetically sealed, moisture and dust proof selector switches and stepping relays are protected from the effects of salt spray, fungus and humidity. Both are hermetically sealed in an inert atmosphere of dry nitrogen with a slight addition of helium tracer.

Illustrated relay qualifies for requirements of shock, vibration, high and low temperatures, and acceleration. Package is available in several standard enclosure sizes. Standard hermetically sealed switches are available with a maximum of four wafers and 105 pins in the header. Devices are capable of many switching combinations. **G. H. Leland Inc.,** 123 Webster St., Dayton, O.

Circle 437 on Inquiry Card





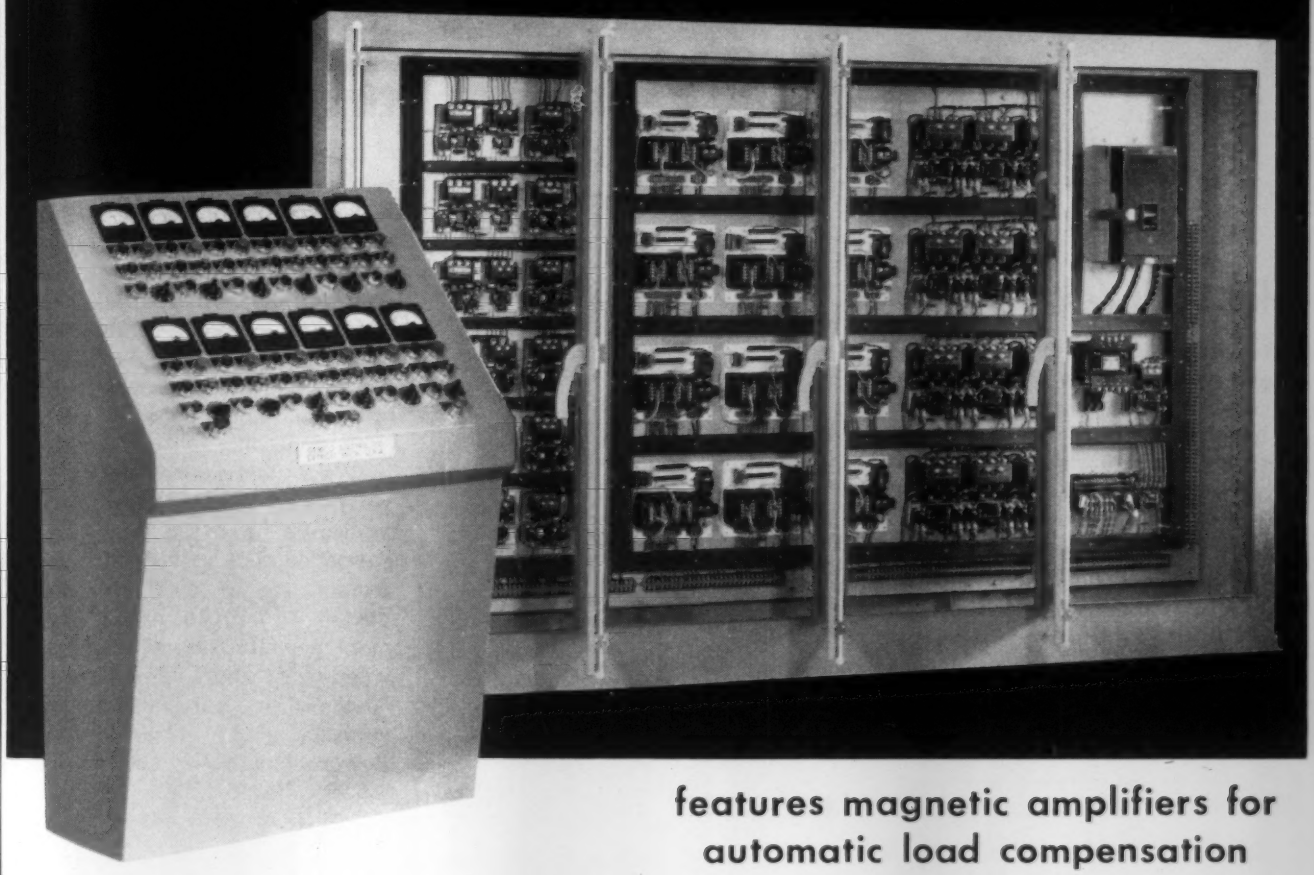
Remote Electric Counter

Designed with a positive clutch drive that permits it to record up to 200 weighings per minute, remote electric counter permits the user to tabulate and record a weighing process from any point in the plant. It can be used to keep production records, as well as to tabulate customers' orders.

Counter's high recording rate is attributed to the speed and accuracy of the clutch arrangement, which prevents double count even when the counter is actuated by chattering contact or a washing mercury switch. Two models are available. Model 31-41 has two rows of digits, one for an accumulative total and one for individual weighings; Model 31-42 records only individual weighings. **Richardson Scale Co.,** Van Houten Ave., Clifton, N.J.

Circle 438 on Inquiry Card

12-SPINDLE polishing stand control



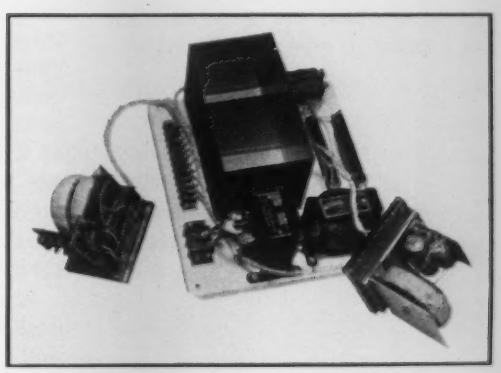
features magnetic amplifiers for automatic load compensation

This Gemco Custom Console enables pre-setting of 12 buffing wheel loads; it saves delays and wasted time by eliminating frequent adjustment to compensate for wheel wear. —

On a new set-up, the operator adjusts each spindle load from dials on the console. Indicating meters read spindle currents.

Key to successful operation is the new Gemco-engineered magnetic amplifier, shown dis-assembled at right. It requires no maintenance; *has no tubes* or moving parts; features exceptionally long life. The master panel contains 12 such amplifiers, along with starters for all heads and all spindle feed motors.

An endless conveyor moves parts under each spindle. Once every conveyor cycle, the current load on each spindle is compared with the pre-set optimum on its magnetic amplifier. If the current is too low, the amplifier causes the feed motor to feed in the wheel to increase the load back to optimum.



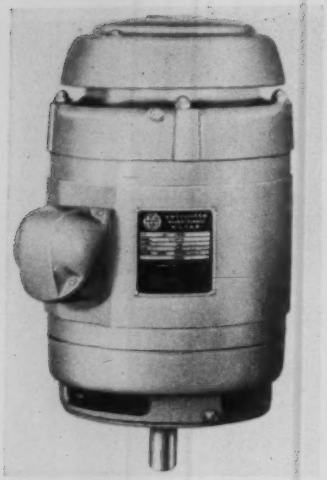
WHAT'S *YOUR* CONTROL PROBLEM?

Gemco designs and builds special controls and systems for all industries, including automatic machining, materials handling, parts testing. For specialized control needs, bring your problems to the control specialists.

GEMCO
CUSTOM CONTROLS

GEMCO ELECTRIC COMPANY · 25681 W. EIGHT MILE RD. · DETROIT 19, MICH.

Circle 592 on Inquiry Card

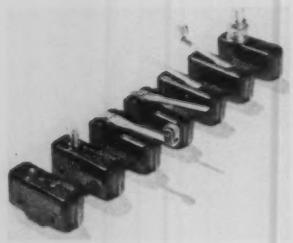


Solid Shaft Motor

Designated Type HV, newly designed vertical solid shaft motor features compact construction for its horsepower rating. Motors are currently available from 1 to 10 hp and will soon be available up to 30 hp. Type HV vertical shaft connection for directly applied power simplifies hookup and unitizes the motor with the driven machine, insuring positive alignment and quiet operation.

Lubriflush system in the motor provides a large volume of fresh grease to surround the bearings. By injecting the grease transversely through the bearing, the old grease is completely purged. **U.S. Electrical Motors Inc.,** Box 2058 Terminal Annex, Los Angeles 54, Calif.

Circle 439 on Inquiry Card

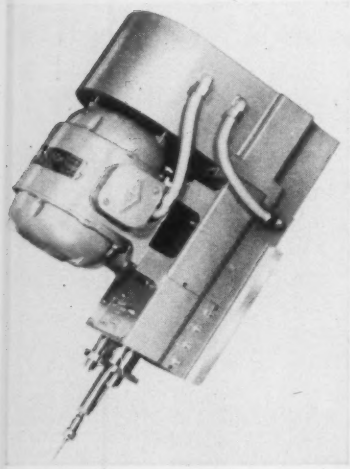


Limit Switches

Designed for aircraft, machine tools, appliances, vending machines and other in-plant uses, Type 10 series limit switches offer movement differentials less than 0.0005-inch for use in operations requiring extreme sensitivity. Serpentine switch mechanism reduces the problem of switch fatigue and assures positive actuation of equipment. Since the switches have no pivot points, they have no dead center and no flickering.

Type 10 series has a 15-amp rating; a 20-amp rating heavy duty type is also available. Seven types of plunger, spring and lever actuators are illustrated (from bottom left to top right): Pin plunger; spring plunger; roller lever; rigid lever; leaf spring; roller leaf spring; and panel mount. **Licon Switch & Control Div., Illinois Tool Works,** 2501 N. Keeler Ave., Chicago 39, Ill.

Circle 440 on Inquiry Card

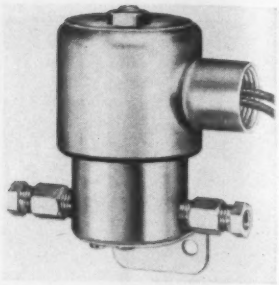


Lead Screw Tapping Unit

Designed to operate in any position, compact lead screw tapping unit has self-contained cycling, drive, electrical and safety features. Unit measures 11 inches wide, 17 inches high and 23½ inches long, and will drive a ¾-inch tap in cast iron, or a group of taps up to this capacity. Tapper has 4-inch spindle travel making it ideal for multiple station arrangements on fixed or indexing tables.

Built-in electrical relays allow automatic or manual cycling. Each unit is provided with its own control panel and is capable of 30 reversals per minute. To avoid tool breakage in the event a tap hits a blind hole, the unit has a built-in, automatic safety clutch and spring-loaded spindle that automatically protects the tool and at the same time warns the operator and returns the spindle. **Johnson Drill Head Co.,** 23rd Ave. & 20th St., ,Rockford, Ill.

Circle 441 on Inquiry Card



Electropneumatic Valve

Recommended for noiseless control of air conditioning damper motors, as well as for control of pneumatic motors and valves on industrial equipment, electrically operated air valve does not talk, hum or chatter. Closely held spring, armature, guide and material tolerances prevent ac hum and other noise usually present in such controls.

When electrically energized, the valve will pass full air at supply pressures up to 25 lb. When not energized, the valve will waste air from its outlet port and close the inlet. A built-in manual adjustment permits the valve to pass air when the coil is not energized. The 60-cycle coil can be supplied for voltages of 115, 208, 230 or 440. **Powers Regulator Co.,** 3434 Oakton St., Skokie, Ill.

Circle 442 on Inquiry Card

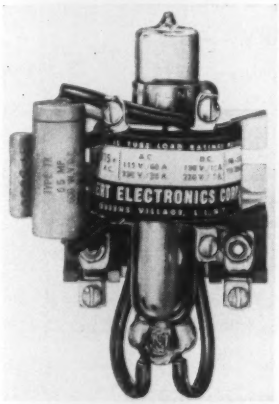
Digital Gaging System

Used in the petroleum and process industries, new simplified digital gaging system remotely measures liquid levels in tank farms of any size over a single wire pair of any length leading to the tank farm area. The operator of the tank gage receiver selects the tank he wishes to measure, causing the selected tank to begin automatically to transmit data. The tank number then lights up in

a group of lamp registers on the left of the panel. Following this, in light register groups to the right, a reading of the liquid level in the tank in feet, inches and fractions of an inch appears.

The tank gaging system will read liquid levels to 64 ft in ⅛-inch increments. The system will read and hold, or scan tank farms automatically. Average temperature can be determined and transmitted with the liquid level information. Cyclic timers can be used also to make readings at preselected times. Coding is such that recorded readings may be made into an electric typewriter or on punched cards. **Pacific Div., Bendix Aviation Corp.,** 11600 Sherman Way, N. Hollywood, Calif.

Circle 443 on Inquiry Card



Sensitive Power Relay

Designed to prevent damage to fine instrument control contacts, HD-8 sensitive power relay allows extremely low surge current through the actuating coil. It requires only 0.0035 amp from an external contact (thermometer, contact meter, probes, etc.) to operate.

Relay load rating is 60 amp at 115v ac; 35 amp at 230v ac; 12 amp at 440v ac on motor, general purpose or tungsten lamp loads. Device employs an energizing coil in a resonant circuit so that the external contact need only carry sufficient power to detune the circuit. Hermetically sealed mercury-to-mercury contact design of the relay reduces maintenance problems. **Ebert Electronics Corp.,** 212-30J Jamaica Ave., Queens Village 28, N.Y.

Circle 444 on Inquiry Card

STOP...

Metal cleaning can be Automated, too!

Don't pyramid your production costs by using hand-operated metal cleaning methods. Detrex cleaning equipment can be built right into your automated line, thus eliminating slow and costly manual labor. In fact, Detrex has been building automated degreasers and washers for years.

Keep your metal cleaning processes in step with the rest of your production. Rely on Detrex quality and experience to maintain the pace. Mail the coupon for complete information on Detrex equipment or check your Sweet's Plant Engineering File.

☐ I am interested in automating my ____degreasing ____washing operation.

☐ Please send literature on standard Detrex equipment.

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DETREX CHEMICAL INDUSTRIES, INC.

BOX 501, DETROIT 32, MICHIGAN

DEGREASERS • DEGREASING SOLVENTS • WASHERS • ALKALI AND EMULSION CLEANERS • PHOSPHATE COATING PROCESSES

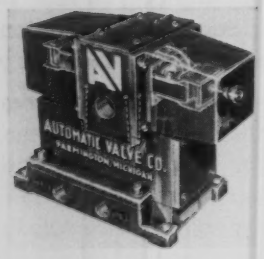
Circle 593 on Inquiry Card

Bin Level Control

Through use of curved Lucite rods to conduct light around corners, No. A-135-134 photoelectric control unit brings reliability to bin level control of granular materials, flasks, powders and small dry solids of all kinds. The rods conduct light from the light source lamp to the photoelectric tube, both of which are mounted in a single sensing head.

When the material level rises and covers the Lucite rods, light from the lamp is cut off from the photoelectric tube. For low level control, a light-energized unit is used with the remote sensing head. For high level control a dark-energized unit is used. Both control units have fail-safe circuits in that failure of a lamp or tube causes the control to energize. **Autotron Co.**, Box 722-RR, Danville, Ill.

Circle 445 on Inquiry Card

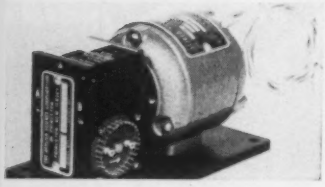


Double-Solenoid Valve

Four-way, four-port and four-way, five - port pilot - operated, double-solenoid controlled air valve is designated Model 2441-500. Valve utilizes a spool type pilot. By momentarily energizing one solenoid, the spool is moved and the main valve shifted. The main valve stays in this position until the other solenoid is momentarily energized and it then shifts back to the original position, providing a safety factor since the valve will not reverse in case of an electrical failure.

Device features waterproof and airtight solenoid enclosures and recessed pins to operate the valve manually without removing covers. Model 2441-500 is available in several sizes. **Automatic Valve Co.**, 37415 Grand River Ave., Farmington, Mich.

Circle 446 on Inquiry Card



Sampling Switch

Used for telemetering, display systems and programming, Type AA sampling switch features two poles with 24, 30 or 32 contacts per pole and sampling rates up to 6 rps. Special construction allows manual phasing of both poles through 360 degrees. Both poles may be manually phased during operation.

Switch will operate efficiently up to 175F and under a wide range of shock and vibration conditions. It weighs 26 oz including the 115v, 60-cycle motor. **Applied Science Corp. of Princeton**, P. O. Box 44, Princeton, N. J.

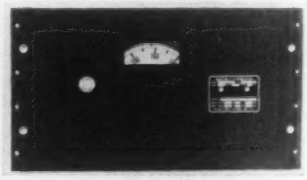
Circle 447 on Inquiry Card

Pressure-Ratio Computer

Compressor inlet and outlet pressures are measured and their ratios simultaneously calculated by pneumatic pressure - ratio computer. Pressure-ratio is a variable which must be regulated in order to prevent flow instability or surge in exhauster, compressor or blower control systems. Model PR-O indicates pressure-ratio on an integral scale and generates a pneumatic signal proportional to pressure-ratio for use in a control system.

Computer is available for applications in ranges of static pressures of from 0 to 10 psia up to 0 to 400 psig. Available for computing on a gage or absolute pressure basis, the device can also be supplied with either a zero base or suppressed scale indication. Pneumatic output signal can be used for control within the normal distance of pneumatic transmission, since the pneumatic output is proportional to the ratio. Remote recording or indication of the ratio can supplement the local mechanical indication within the computer. **Hagan Corp.**, 323 Fourth Ave., Pittsburgh 22, Pa.

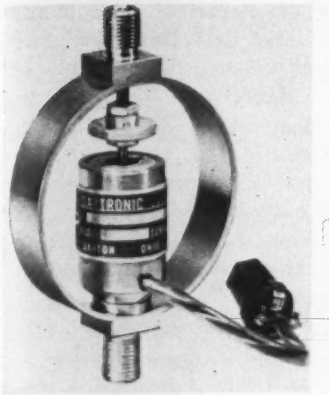
Circle 448 on Inquiry Card



Potentiometer

Equipped with a pneumatic transmitter which sends a 3 to 15 psi signal proportional to the measured variable, electronic potentiometer transmits pneumatic signals. Dynamaster pneumatic transmitter is available in either potentiometer or bridge circuits, and will measure any variable which can be translated into an electrical quantity. It then converts the measurement into a universal 3 to 15 psi pneumatic signal for transmission to a remote pneumatic indicator or recorder, or automatic controller. Thus, it is possible to present measurements such as speed, viscosity, pH, resistance, smoke density, current and voltage, frequency, and conductivity on the miniature pneumatic receivers, along with the more conventional measurements of flow, pressure and temperature. **Bristol Co.**, Waterbury 20, Conn.

Circle 449 on Inquiry Card

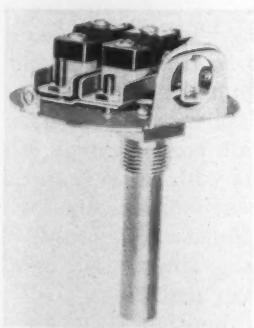


Force Transducers

Improved accuracy and additional ranges are features of Series 140 force transducers. Combining the proving ring and differential transformer principles, transducers provide an electrical output voltage that is precisely proportional to applied force, and exhibit high stability of calibration.

Available in 11 models with ranges from ±10 to ±100,000 lb, units are accurate to 0.5 per cent. Excitation frequency range is 60 to 10,000 cps. Maximum sensitivity is 40 mv per volt at rated load. Accessory instrumentation for remote indication or recording of static and dynamic outputs is available. **Daytronic Corp.**, 216 S. Main St., Dayton 2, O.

Circle 450 on Inquiry Card



Heavy Duty Thermostat

Two independent electrical circuits can be controlled simultaneously with Series 22000 dual-control Thermoswitch. Thermostat consists of a liquid filled sensing element, containing a sensitive bellows and push rod assembly which actuates two precision miniature snap switches mounted in the head. Each switch may be

IMMEDIATE DELIVERY

ANY SIZE • ANY MOUNTING • ANY STROKE

from CARTER

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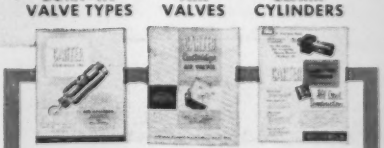
CYLINDERS

AIR OR HYDRAULIC

Don't let cylinder delays hold up your production. Carter will give you IMMEDIATE DELIVERY on standard cylinders — *any bore size, any mounting, any stroke!* This is due to our recent 100% expansion in plant capacity, 3 shift operations, and the exclusive CARTER design which permits off-shelf assembly from standard parts.

This is the way we can and do serve our customers, regularly, day in — day out. We will serve you the same way. Call on us today for IMMEDIATE DELIVERY.

BUILT-IN VALVE TYPES | AIR VALVES | CLAMP CYLINDERS



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All the details you need. Prices, specifications, spare parts information. Send for your complete file today.

AIR CYLINDERS | 750 LB. HYDRAULIC | 1500 LB. HYDRAULIC

CARTER Cylinders feature:

STRENGTH - DURABILITY — Precision honed heavy wall tubing . . . 10 to 1 safety factor . . . heavy duty chrome plated rod as standard. Long life, leakproof performance.

SIMPLICITY OF DESIGN — Integral cast steel head and mount united with cylinder wall by means of key type lock ring. 360° orientation of pipe ports. Leakproof construction.

EASY MAINTENANCE — Easily disassembled. Replacement of parts is simple, quick. No skilled help needed. Cartridge Rod Bearing allows on-the-job replacement without disassembly of cylinder.

SPACE SAVING ADVANTAGES — No bolts, no tie rods . . . Carter's compact design of both cylinder and mount saves 40% in space.

CARTER CONTROLS INCORPORATED
2977 Bernice Road • Lansing, Illinois (Chicago Suburb)
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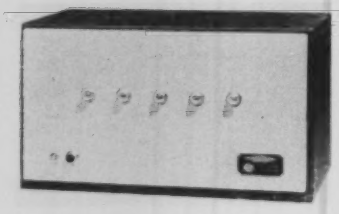
ROTARY ACTUATORS • SPECIAL CONTROLS

Circle 594 on Inquiry Card

connected to operate a separate electrical circuit.

Thermostat can be specified to operate over one of three service temperature ranges: −75 to 125F, 25 to 225F, and 100 to 300F. A differential setting arrangement is also available. Applications for the thermostat include control of heating and cooling equipment in a constant temperature process; step control of a process to actuate various dampers, valves, recirculating lines, etc. in response to two critical temperatures; control plus high-limit cutoff or alarms, or any other application in which separate control or detection actions are desired at two temperatures. Switches are available to handle up to 20 amp at 125 or 250v ac, or 10 amp at 125v dc. **Fenwal Inc.**, Ashland, Mass.

Circle 451 on Inquiry Card

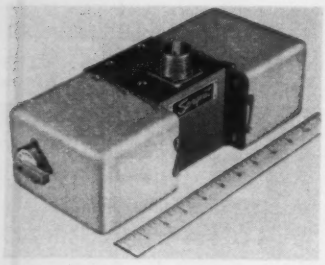


Input Counter

Applicable to all types of industry where the total count of daily production is required from more than one line, MC multichannel input electronic counter records an accurate count of any number of production lines. In operation, a separate photohead is located on each line where the count is to be picked up. As each object breaks the photobeam, a pulse is recorded in the MC, which in turn relays the pulse to the counter. Should the photoheads be interrupted simultaneously, the count will still remain accurate, due to the anticoincidence feature of the unit.

Model MC provides a method for high speed batching by allowing any number of conveyors to accumulate into one common collection point. Unit is also adaptable to accumulating production information where several sources of the products are involved. **Electronic Products Div., Post Machinery Co.**, Beverly, Mass.

Circle 452 on Inquiry Card

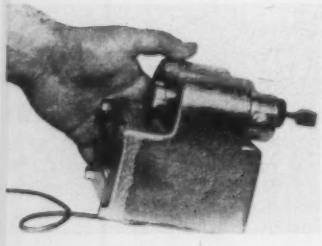


Hydraulic Valve

Used in missile launching systems, heavy-duty, two-position solenoid controlled hydraulic valve is actuated by continuous duty, long life, balanced rotary solenoids and operates on 95 to 125v, 60 cycle, single-phase ac power. Valve is equipped with moisture proof housings and can be left continuously energized in 165F ambient. Shaded poles are used to reduce ac hum.

Lapped, hardened rotor and sleeve assembly affords low leakage, insensitivity to dirt, low friction and low flow forces. Valve has no reciprocating components. All moving parts are rotary and dynamically balanced. Unit operates in ambient from −20 to 165F in 1500 psi or 3000 psi hydraulic systems. Capacity is 1.5 gpm at 200 psi total pressure drop. Valve can be used as a pilot unit for operating larger valves or as an independent subplate mounting valve. **Sargent Engineering Corp.**, 2533 E. 56th St., Huntington Park, Calif.

Circle 453 on Inquiry Card



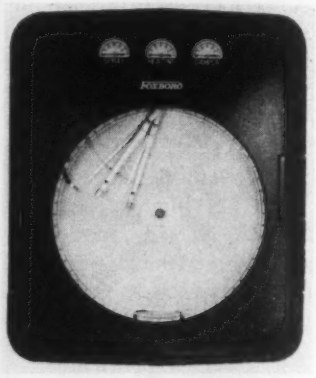
Fluid Level Detector

Consisting of a motor generator driven at resonant frequency by an ac current input, fluid level detector is called Dynatrol. Unit is sensitive only to level variations and is accurate to 0.01-inch.

In operation, the output of the generator energizes a rugged relay to control the operation of any type of electrical equipment. For high level detection, the generator output ceases as a result of the fluid rising and stopping the vibrating paddle, thereby causing deenergization of the control relay. For low level detection, the generator output energizes a control relay when fluid level drops and allows the paddle to vibrate.

Standard model is explosion-proof and is rated at 115v ac, single-pole, double-throw, 1000 psig at 150F. **Automation Products Inc.**, 3030 Max Roy St., Houston 24, Tex.

Circle 454 on Inquiry Card

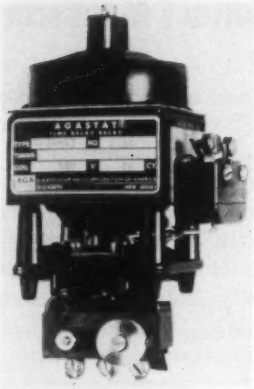


Dry Kiln Controller

Designed specifically for use in lumber drying operations, dry kiln instruments have rectangular case construction for panel or surface mounting. Series includes both single-zone (illustrated) and multizone temperature humidity recorder controllers. Single-zone units for small compartment kilns are available with or without dual dry bulbs and duplex wet bulb control. Multizone controllers for long compartment and progressive kilns are also furnished with or without dual dry bulbs and duplex wet bulb control.

While *On-Off* wet and dry bulb control units are standard, narrow band proportional control is an optional feature and is particularly useful in reducing damper whipping. Other features include color coding of pens, setting indexes and knobs, control relays, output pressure gages and other components, simplifying kiln operation and instrument maintenance. **Foxboro Co.**, Foxboro, Mass.

Circle 455 on Inquiry Card

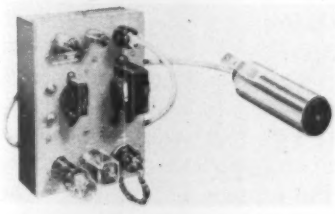


Time Delay Relay

Electrical interlock and two-step timing are available with Agastat time delay relay. Model NETL is a combination unit with two normally closed limit switches and a basic Agastat relay. Contacts of the limit switch are on the front side of the relay and are held in the open position by a lever before energization. Upon energization of the relay coil, the contacts close instantly, locking in the circuit. The two-step timing action then takes place. A second limit switch attached to the bottom of the relay provides the two-step timing.

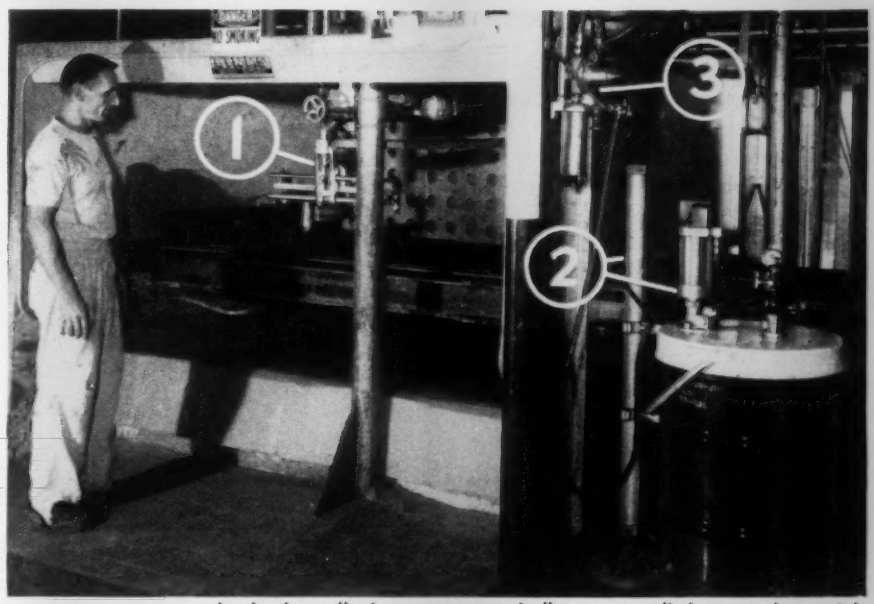
Units are available for ac or dc operation, intermittent or continuous duty, in single-pole, double-throw; double-break and double-pole; double-throw, single-break models. Relay is rated 15 amp at 115v, 60-cycle ac. **A'G'A Div., Elastic Stop Nut Corp. of America,** Elizabeth, N.J.

Circle 456 on Inquiry Card



Proximity Limit Switch

Mechanical motion is converted into an electrical signal without physical contact between the part and the switch by proximity limit switch, with the requirement that the part be of ferrous material. Available with either relay output or tube output—the latter eliminates all moving parts, the proximity switch may be used in



Laminating adhesives are automatically spray applied to panel materials by this Binks system comprising: (1) an automatic reciprocating spraying machine in conveyorized spray booth, (2) a material handling pump and pump elevator, and (3) an oil and water extractor and accessories.

at Panelfab Products, Inc., North Miami, Fla...

Automatic spraying of adhesives saves material...assures even bond

Mr. Carl M. Kromp, plant manager at Panelfab reports:

Perfect bond—every time

"Since installing a Binks automatic reciprocating spraying machine for the application of adhesives to our panels, we get even coverage. There are no skips or thin spots to cause bond failure. Perfect bond is a must as we make structural building panels by laminating facing materials such as hardboard and aluminum sheets to a honeycomb core."

Improved production

"Automatic control over adhesive application prevents waste too. Adhesive is pumped direct from original shipping drums...no need to transfer material from one container to another. An elevator lifts the pump for easy exchange of drums. Conveyorized spray booth and Binks automatic reciprocating machine maintains steady production rate – eliminates fatigue element associated with manual methods."

As was the case with Panelfab, no matter what liquid or semi-liquid you may now be applying in your production process—it will pay you to talk to Binks.

Free analysis and engineering help:

If you would like to know what production rates or costs you could obtain with Binks spraying systems, Binks research department will run an actual test on your products and give you a detailed report. *No obligation*—call your Binks Branch Office or write direct.

Ask about our spray painting school
Open to all...NO TUITION...Covers all phases

692

Binks
EVERYTHING FOR SPRAY PAINTING

SPRAY GUNS

AIR COMPRESSORS

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3132-40 Carroll Ave., Chicago 12, Illinois

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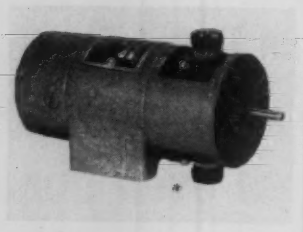
Circle 595 on Inquiry Card

existing standard 110v control circuits. Relay type panel has an output capacity of 5 amp and the fully electronic type has sufficient capacity to energize a small control relay.

Switch is used with small parts, fast moving parts, and parts with rough edges. The sensing head is not affected by vibration or the presence of nonmagnetic foreign material on its surface, thus lending itself to a variety of applications in paint spray systems, stamping presses and heavy automation equipment. Sensitivity of the switch is such that large parts can be sensed at distances up to 1½ inches from the transducer head. **Square D Co.,** 4041 N. Richards St., Milwaukee, Wis.

Circle 457 on Inquiry Card



DC Tachometer Generator

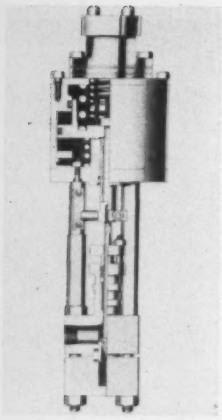
Used where precise speed indicating for visual or automatic control is needed, dc tachometer generators are available in two basic models, depending on the degree of compensation required. Units can be furnished with outputs held to less than 0.1 per cent or to less than 0.25 per cent voltage variation due to temperature changes, over a range of −40 to 100C.

Generators are available in six basic frame sizes and mounting types. Available outputs are from 1 to 175v per 1000 rpm, with operating speeds up to 10,000 rpm or higher as required. **Electric Indicator Co.,** 100 Camp Ave., Springdale, Conn.

Circle 458 on Inquiry Card

Flow Control Valve

Designed for working pressures to 6000 psi, small flow control valve is designated Model 9460. Valve features a differential area piston which eliminates the need for loading regulator and will



stroke fully in either direction in 0.75 seconds or less. Open-on-air-failure or close-on-air-failure action plus interchangeable valve trim in C_v 0.005 to 2.5 are also available. Offset globe or angle bodies are featured with body sections, rotatable in 90-degree increments for piping convenience. **Annin Co.,** 6570 E. Telegraph Rd., Los Angeles 22, Calif.

Circle 459 on Inquiry Card

Pilot Lights

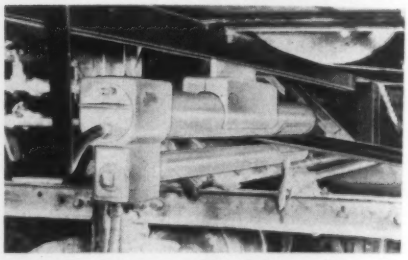
Well suited for civilian and military applications where lighted messages are required, subminiature pilot lights feature rotatable lenses. Spring-mounted lens assembly is made to rotate smoothly to enable positioning after the entire pilot light is screwed into place.

In this series, figure, letter or word is hot stamped into the flat face of the translucent plastic lens. Since the light bulb is just below the surface of the lens, a bright and even distribution of light is afforded. Imbossed legends are filled in for sharp contrast. Lights are designated Series No. 134-3830-375. **Dialight Corp.,** 60 Stewart Ave., Brooklyn 37, N. Y.

Circle 460 on Inquiry Card

Noncontact Measuring

Used to measure and control sheet thickness, weight, coatings, etc., in continuous manufacturing processes, new unit called the Betameter is particularly adapted to measurements which cannot be made with conventional equipment because the instrument does not physically contact the measured materials. The device employs beta radiation for accurate measurement of mass per unit area of material.



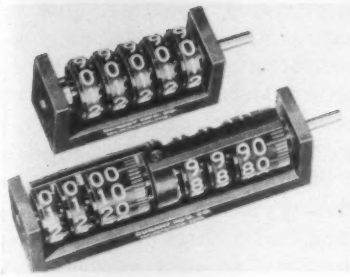
The Betameter is designed on the principle that all materials absorb beta rays—the greater the mass, the greater the absorption and the fewer number of rays which pass through the material. By measuring the rays which do get through, an accurate measurement of mass per unit area is obtained.

In the measurement of sheets with the device, a sealed source emitting beta rays is mounted on one side of the sheet, a radiation detector on the opposite side. Current generated in the detector is correlated directly with the sheet mass and therefore with the sheet thickness. Feature of the Betameter is the principle of null balanced operation which provides a means of continuous standardization. Decay of the radioactive source, effects of air pressure and temperature are canceled out continuously and automatically, with no need for standardization interruptions. **Isotope Products Inc.,** 1700 Niagara St., Buffalo, N. Y.

Circle 461 on Inquiry Card

Instrument Counters

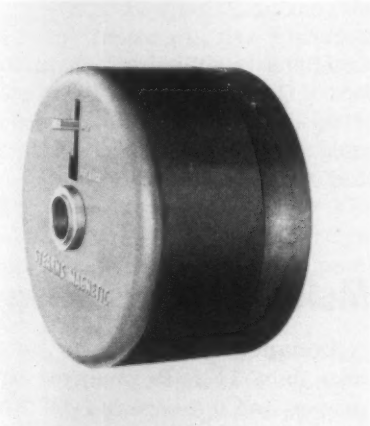
Used as readout indicators on navigation instruments, missile tracking instruments, radar controls, computers and other instrument and electronic applications, counters are designated as Y In-



strument Series. Series is made up of a family of 96 different models, each with identical configuration of case, wheels, and components, permitting the manufacturer to have continuity throughout the various types of equipment on which the readout indicators are used.

Y family group will take care of all applications requiring the same configuration of counter, and the wide choice of units in the series is effective where a manufacturer must use more than one counter in a particular design of instrument or equipment. Model variations are: single-bank readout counters from two to seven-figure capacity, and double-bank counters from two to five figures in each bank. Counters have a speed up to 2500 rpm intermittent duty. **Durant Mfg. Co.**, 1997 N. Buffum St., Milwaukee 1, Wis.

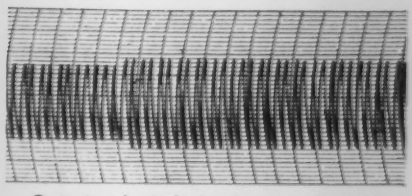
Circle 462 on Inquiry Card



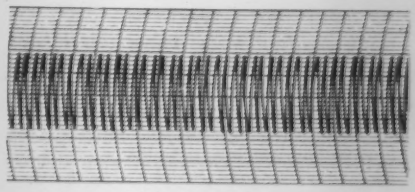
Magnetic Disk Brake

Used for through-shaft applications, AT-50 series magnetic disk brakes are designed for mounting on fractional horsepower motors built in the 56-C and 66-C frames and on the integral horsepower motor frames 182 and 184. Units cover the braking requirements for

Regulation in *less than 1/50th cycle . . .*



Output of typical electromechanical regulator in response to step change in input voltage. Average correction rate of 6v. per sec.



Output of Curtiss-Wright Distortion Eliminating Voltage Regulator from same input. Full recovery in 330 microsec.

Simultaneous two-pen recording of 60 c.p.s. voltage

PLUS **Pure Sine Wave Power**

CURTISS-WRIGHT LINE REGULATOR

- **Electronically regulates r.m.s. and peak voltage simultaneously to ±1%.**
- **Reduces typical power line distortion to less than 0.3%.**
- **Furnishes 1.4 KVA of distortion-free power.**
- **Introduces no phase shift between input and output.**
- **Simultaneously provides additional 4 KVA of ±1% electromechanically regulated power.**

Faster recovery time (less than 1/50th cycle, or 330 microseconds) plus the unique ability to *eliminate* line distortion — these are the reasons why the Curtiss-Wright Distortion Eliminating Voltage Regulator has been chosen by more and more laboratories and production test departments. Besides general laboratory use, this line regulator provides simpler, more accurate calibration of meters . . . better design of transformers, synchros, motors . . . easier testing of such components, with fewer rejects . . . easier, more accurate measurement of magnetic properties and receiver sensitivity . . . better a.c. computer performance . . . elimination of fast line transient effects. Write for details.

Electronic Component & Instrument Sales Department

ELECTRONICS DIVISION
CURTISS-WRIGHT
CORPORATION • CARLSTADT, N. J.

Circle 596 on Inquiry Card

motor ratings from 1/6 to 2 hp. Standard brakes may be supplied with special brackets to permit mounting independent of the motor.

Magnetic disk brake is spring set and solenoid released. It automatically sets in the event of power failure. The brake is electrically released by the solenoid action which removes the spring pressure from the friction elements. The force of the solenoid is transmitted through a lever system. Brake is available for ac and dc operation. It may be supplied for operation with vertical, wall or ceiling mounted motors. Unit is designed so that the motor shaft extends through the center and out beyond the end of the brake, permitting drives off both ends of the shaft. **Stearns Electric Corp.,** 635 S. 28th St., Milwaukee 46, Wis.

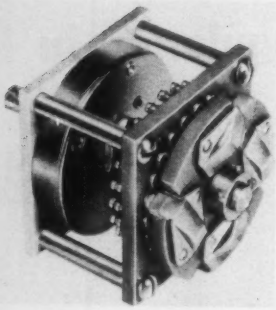
Circle 463 on Inquiry Card

Flow Rate Indicator

Designed primarily for use with F&P's turbine flow meters, direct reading in-line flow rate indicator features a completely digital system, operating from the frequency output of the turbine meter, which takes full advantage of the linearity and repeatability inherent in the turbine meter primary. Indicators provide automatic, frequency controlled range switching and direct reading of flow, with manual correction for specific gravity as an optional feature. Conversion into the desired flow units and correction for the calibration factor of the primary are accomplished electrically.

In addition to straight indication, the digital information stored in the indicator can be fed directly to complete data handling and automation systems. Inch-high numbers, engraved in clear plastic and edge-illuminated, provide instant visual readout up to 25 ft away. **Fischer & Porter Co.,** 758 Jacksonville Rd., Hatboro, Pa.

Circle 464 on Inquiry Card



Rotary Switch

New version of knee action rotary switch is designated Type 142-CM. Switch is 1¾ inches square and is available with as many as four poles on a single deck. As many as seven positions per pole with shorting action, and four positions per pole with nonshorting action, can be obtained with the units.

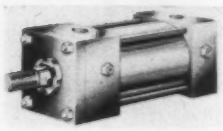
Device employs rotors, slip rings and contacts of solid silver alloy. Turret-type terminals, gold plated to facilitate soldering, are supplied for easy wiring. Switch can be supplied in multideck arrangements with as many decks as required. In the single-deck version, the switch can be furnished as a round unit. Type 142-CM is capable of several million cycles of operation. Roller-type detent is used for accurate contact positioning. **Daven Co.,** 530 W. Mt. Pleasant Ave., Livingston, N. J.

Circle 465 on Inquiry Card

Counter Timer

Designed for the precise measurements of frequency ratio, period, and time interval, counter timer is designated Model 226A. Pressure, velocity, acceleration, displacement, flow, rps, rpm, etc. may be measured with suitable transducers. Unit may also be used as a secondary frequency standard. Features of timer are: Simplified color coded controls and direct readout in kilocycles, megacycles, seconds or milliseconds with automatic decimal point indication; provision for oscilloscope marker signals for trigger level adjustment of start and stop points for time interval measurement of complex waveforms; three independent continuously adjustable trigger level controls permitting full rated sensitivity at any voltage level between −300 and 300v. **Computer-Measurements Corp.,** 5528 Vineland Ave., N. Hollywood, Calif.

Circle 466 on Inquiry Card



Air Cylinder

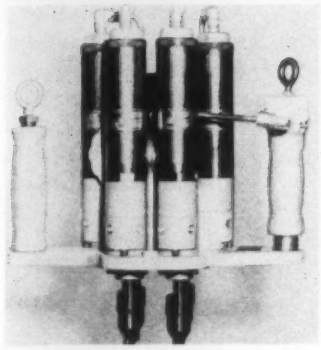
Square end, space saving air cylinders are available in 11 bore sizes from 1½ through 14 inches, and with 21 types of mountings. Cylinders feature brass tubes to eliminate corrosion, removable bronze cartridge containing wiper and rod packing, and cold rolled steel end plates. The chrome plated rod has four wrench flats and is available in optional sizes. Pistons and tie rods are secured with lock nuts. On cushioned models, cushions float on an O-ring for accurate self-alignment, providing excellent cushioning characteristics. Cylinders can be supplied with either single or double rod ends. **S-P Mfg. Corp.,** 12415 Euclid Ave., Cleveland 6, O.

Circle 467 on Inquiry Card

Multiple Screw Drivers

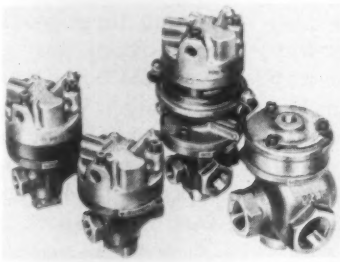
Designed specifically for torques less than 11 ft-lb, multiple screw drivers and nut setters feature new designs. Two sizes of offset gear arrangements make allowable distances between bolt centers as low as 1 3/16-inches with standard parts, making possible multiple driving in the lower torque ranges. Offset attachment with a 2 to 1 gear ratio makes it possible to attain up to 27 ft-lb torque from the nut setters.

Designed to provide high power in small diameter air motors, five



models of these tools offer 18 complete selections of motors. Tool speeds range from 225 to 2800 rpm; torques range from 2.3 to 27 ft-lb. One-piece head and motor housing provides remote control connections. Housing contains muffling facilities and a deflector which directs the exhaust air from the lower end of the motor housing. **Keller Tool Div., Gardner-Denver Co.**, Grand Haven, Mich.

Circle 468 on Inquiry Card

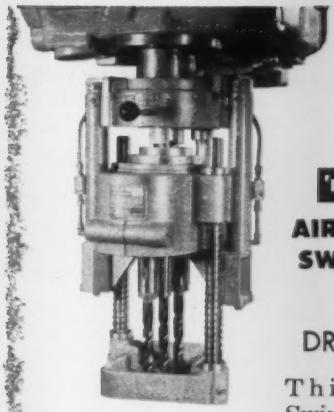


Sequence Valves

Sequencing type air circuits can be controlled by sequence valves designated TD and WV. Units provide for a preset pattern of operations to be automatically carried out by a machine after the operator initiates the cycle. Cylinders can be sequenced by position or time, and their action interlocked in the circuit.

When a pilot valve is operated, it provides the remote control valve with air through an opening in the head, reversing the valve. Exhausting the pilot valve circuit returns the remote control valve to its normal position. Available models include straightways and three-ways, normally opened and normally closed. Valves are provided for in-line mounting, in sizes ¼ to 1¼ inches. **Ross Operating Valve Co.**, 120 Golden Gate, Detroit, Mich.

Circle 469 on Inquiry Card



NEW

Drill Head

AIR COUNTERBALANCE SWIVEL ATTACHMENT

FOR RADIAL DRILLING MACHINES

This new combination Swivel and Air Counterbalance attachment makes it possible to adapt large multiple spindle drill and tapping heads to radial drilling machines. Flexible and easily adjusted, it insures maximum safety for the operator, as well as better operating economy.

Attachment includes air filter, pressure regulator, and an air oiler, and incorporates a 360° swivel feature fully aligning the drill head. It operates equally well with the fixed center type head and the adjustable type head.

This package is ideally suited for drilling condenser plates, boiler tube sheets, flue sheets, etc.

Manufacturers of all types of Fixed Center, Adjustable, and Individual Lead Screw Tapping Heads

US DRILL HEAD

THE UNITED STATES DRILL HEAD COMPANY

BURNS STREET • CINCINNATI 4, OHIO

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NOW! DRUMS ALTERNATED AUTOMATICALLY

on New Alvey-Ferguson Conveying System!

PARTS or products, cans or cases, drums or barrels—whatever must be moved in your plant, can be moved more efficiently and for less money on A-F Engineered Conveying Systems. Whatever your needs—a complex, completely automated system or single conveyor—write us.

One instance of A-F Engineering—the automatic shunting of drums into 2 lines (shown here) so that they may be picked up in groups of 4 by a special fork lift truck. No pallets needed.

YOU CAN SEE THE SUPERIORITY OF A-F CONVEYOR ENGINEERING

A-F

A-F *Engineered* Conveyors

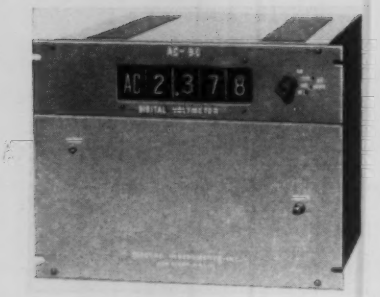
Custom Engineered Conveying Systems

Pre-Engineered Conveyors—Wheel, Trolley

Metal Cleaning and Processing Machines

THE ALVEY-FERGUSON CO., 175 Disney Street, CINCINNATI 9, OHIO and Azusa, Cal.

Circle 598 on Inquiry Card



AC-DC Digital Voltmeter

Greater sensitivity is feature of four-digit, ac-dc digital voltmeter which automatically measures ac voltages with 1/10 mv sensitivity. Reading time for the new instrument averages 2 seconds on ac, and 1 second on dc readings. Readings are made automatically and presented on an in-line readout. One-inch high numerals can be read from 30 ft away, eliminating chance of reading errors and ambiguities.

Range of the instrument is 0.001 to 999.9v dc and 0.0001 to 999.9v ac. Range switching is manual on ac and automatic on dc. Ac accuracy is 0.1 per cent of full scale; dc accuracy is ±1 digit. Frequency response is from 30 to 10,000 cycles at 10 megohms, 20 micromicrofarads. Stability is 0.01 per cent from 40 to 120F, with automatic dc calibration. **Electro Instruments Inc.,** 3794 Rosencrans St., San Diego, Calif.

Circle 470 on Inquiry Card

Clutch and Brake

Miniature, dry powdered iron clutch and brake are each designated as Model #10. Lightweight clutch has a rating of 80 inch-oz torque at approximately 5000 rpm and an output inertia of 1.85 gr cm^2. The speed of response is in the order of 2 milliseconds. Since the excitation coil is fixed, slip rings and external bearings are not required. Unit has only two moving parts. Clutch offers either *On-Off* or proportional control up to 100 per cent slip; same ratings apply for either direction of rotation.

Model #10 brake is a high-speed, reversible device that delivers 80 inch-oz torque for either *On-Off* service and/or for a proportional drag. Ratings are the same for either direction of rotation. **Electomic Mechanisms Inc.,** P.O. Box 1156, Greenwich, Conn.

Circle 471 on Inquiry Card

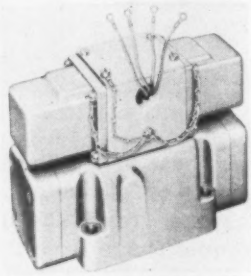
Proximity Transducers

Series of high-frequency, carrier operated proximity transducer systems is available in two types—4950-B and 4950-RB. Utilizing a principle employed in miltary mine detectors to sense the presence of metal objects without contact for counting, controlling motors or valves and actuating warning devices, transducers feature wide ranges, high sensitivity and fast, long-life relays.

Both available systems operate on 115v ac input and feature a sensitivity control which adjusts to desired operating ranges and compensates for surrounding temperature changes. The B system is used primarily with electronic equipment; RB system contains a single-pole double-throw mercury relay for controlling various kinds of electrical machinery. Relay feature in the RB system raises the top limit for electrical operations to 3600 per minute with a life of over 1 billion operations.

With transducers, metal objects can be sensed up to ¾-inch away through such nonmetallic substances as plastic, paper, pasteboard or wood, at rates up to 1000 units per second. **Electro Products Laboratories,** 4500 N. Ravenswood Ave., Chicago 40, Ill.

Circle 472 on Inquiry Card



Hydraulic Valves

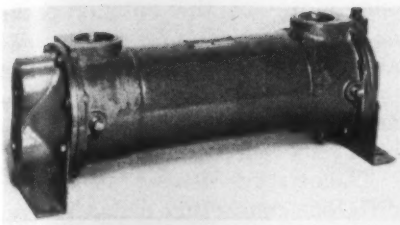
Identified as Logan 9700 series, line of hydraulic control valves have operating pressures to 3000 psi and continuous duty solenoids. Valves are pilot operated with subplate mounting. Types available are: Two and three-position, four-way; two-position, two and four-way. Available sizes range from ⅛ to 1¼ inches. Valves feature internal or external pilot pressure and drain, and open or closed center type spools. **Logansport Machine Co. Inc.,** Logansport, Ind.

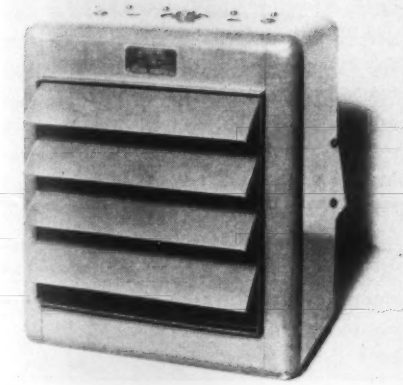
Circle 473 on Inquiry Card

Oil Coolers

Air and water type oil coolers for industrial hydraulic systems feature a high rate of heat transfer per unit of space occupied. Designated Series OCW, water type oil coolers (above) are available in single unit sizes for oil flows up to 100 gpm and for continuous power removals up to 37 hp (based on 85F entering water temperature).

Series OCA air type oil coolers (below) are recommended where cooling water is at a premium and/or waste heat can be used to warm space. Their high heat transfer rate in relation to size results from a patented turbulator that breaks up the flow for maximum dispersion of oil against the walls of the heat transfer tubes. OCA coolers are available in single unit sizes for oil flows up to 70 gpm and for continuous power removals up to



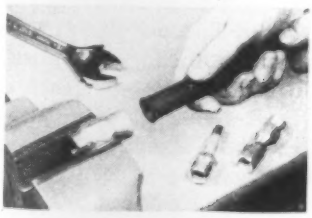


13.2 hp (based on 100F average ambient temperature). **Vickers** Inc., Deetroit 32, Mich.

Circle 474 on Inquiry Card

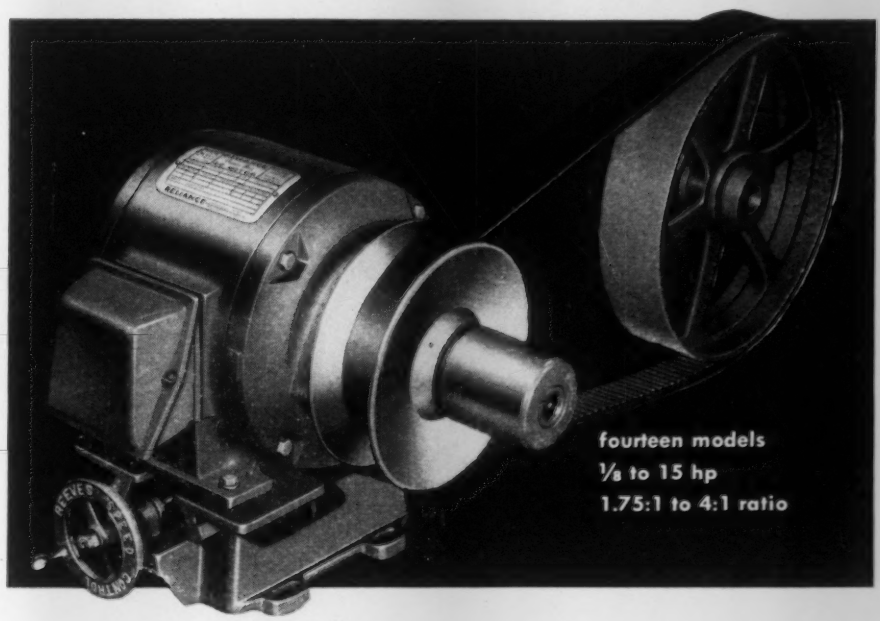
Hose Fittings

Suitable for service with hydraulic fluids, hot oil, grease, lubricants, crude and fuel oils, gasoline, liquefied petroleum gas, air and water, "no-skive" type reusable fitting consists of a socket and nipple. It does not require the hose cover to be stripped off. Make-up is accomplished in two steps: The hose is rotated into the socket counterclockwise, and the nipple is screwed clockwise into the hose and socket.



The lead thread of the socket cuts through the rubber cover of the hose, permitting the following threads to contact the wire braid. This engagement forms a grip that holds beyond hose bursting pressures as well as under severe vibration conditions. The rubber of the hose cover is compressed between the threads of the socket and acts as a vibration damper.

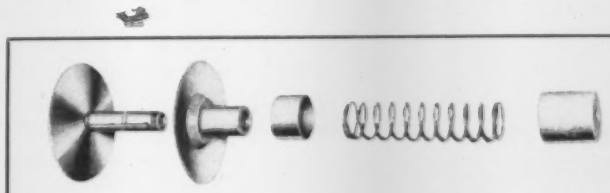
The low-cost answer to wider use of your machines



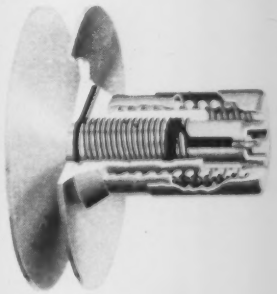
REEVES

Vari-Speed Motor Pulley

Add the advantages of accurate variable speed control to your existing machinery with this compact unit. Add versatility and extended life . . . handle more shapes, sizes and materials!



REEVES "Close-grooving" —a special lubrication system—insures free sliding disc for easy speed changes.



For bulletin complete with rating charts and dimensions, write Dept. AN21-V545.

REEVES PULLEY COMPANY
Division of **RELIANCE** ELECTRIC AND ENGINEERING CO.
Columbus, Indiana

Circle 599 on Inquiry Card

STANDARDIZED AUTOMATION

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ROTARY TRANSFER ASSEMBLY MACHINES

Index Tables, Power Assemblies, Stands and Control Panels Now Standard and Cataloged —

MANY IN STOCK AT SUBSTANTIAL SAVINGS!

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There has never been anything like it! 24 pages of engineering data vital to anyone interested in automatic assembly. More than 150 high speed, precision index tables cataloged by dial sizes from 12" to 120"; 4 to 36 stations; and indexing periods varying from ¼ to ¾ of the cycle time. Load ratings are shown for various RPM. All dimensions are given. Standard power assemblies are shown with speeds and dimensions. Stands, electrical control panels and other auxiliary items are listed. *You can even order a complete rotary transfer machine from stock with weeks off normal delivery time and substantial price reductions!*

Convert to STANDARDIZED AUTOMATION . . . with Ferguson Intermittor Index Tables and Rotary Transfer Machines. Add your own tooling or let Ferguson design and build it for you. Get all the benefits of standard machinery with the advantages of special equipment.

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FERGUSON MACHINE CORPORATION

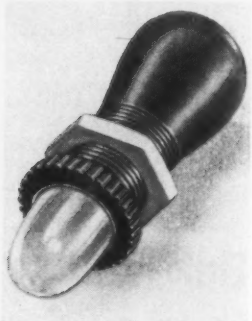
ROLLER GEAR DIVISION, DEPT. AI-11 P. O. BOX 5841, ST. LOUIS 21, MO.

Circle 600 on Inquiry Card

adding life to the holding power and stress resistance of the hose at the joint where flexing can lead to hose failure, especially in connections where the hose cover has been removed.

The no-skive Hose-lok offers four different connecting ends: Tapered male pipe thread, straight thread with O-ring sealing, J.I.C. standard Triple-lok 37-degree flare nose for tube connection, and swivel nut for connection with any Triple-lok adapter. Hose has an outer cover which is resistant to oil, weather and abrasion. **Tube & Hose Fitting Div., Parker Appliance Co.,** 17325 Euclid Ave., Cleveland 12, O.

Circle 475 on Inquiry Card



Neon Indicating Light

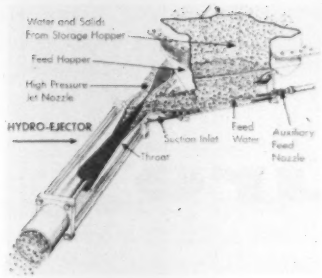
Designed for use with taper pin terminals, indicating light assembly has the features which make neon lamps useful in many applications. Assembly extends only 1 1/16-inch back from the front of the panel when installed, making the unit useful in installations where space is at a premium.

Taper pin terminal style and the use of E-Z-Tite nut which features extra-deep knurling for quick and positive assembly are features of the No. R-115 unit. Minimum center-to-center spacing is 5/8-inch. **Drake Mfg. Co.,** 1713 W. Hubbard St., Chicago 22, Ill.

Circle 476 on Inquiry Card

Jet Pumps

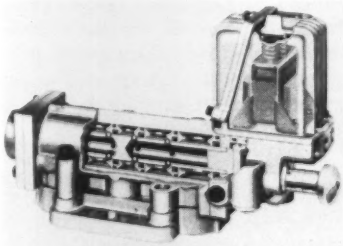
Designed to transport solids through pipelines, Hydro-Ejector jet pumps are available in four sizes—for 4, 6, 8, and 10-inch transport pipelines. Because the jet nozzle tip is located out of the path of the materials being handled, it



cannot interfere with the free flow of solids. Unit is installed with a water-tight housing with access door, observation window and emergency flow connection which encloses the feed hopper and the discharge opening of the storage hopper.

Iron pyrites can be transported in the same system which conveys bottom ash or furnace slag. Combined operation not only saves time and water, but uses the greater specific gravity of a water and ash mixture to carry the heavy pyrites at a higher rate. Hydro-Ejector can be equipped with special gaskets to withstand the effects of acids, alkalis and high temperatures. **Allen-Sherman-Hoff Co.**, 259 E. Lancaster Ave., Wynnewood, Pa.

Circle 477 on Inquiry Card



Control Valves

Used to make automated interlocking operations more dependable and productive, new *B*-Type control valves are for air and hydraulic operation. The valve chambers are formed by aluminum spacers held in accurate metal to metal end abutment. This patented arrangement simplifies internal construction. It permits the O-rings or U-packers to be supported on both the inside and outside diameters without placing any mechanical pressure on the packers, and allows quick, easy servicing in the field.

The hollow, radially ported, stainless steel plunger is the only moving part except the operating mechanism. Flow is from the inlet chamber through the radial ports of the hollow plunger and out through other ports in the plunger to the connected line. All parts are in pressure balance eliminating any tendency to creep or crawl. Dual exhaust in four-way valves permits the speed of the operated piston to be controlled by installing adjustable exhaust plugs in the valve subbase.

Valves are rated at 600 cycles per minute for continuous operation on air at pressures from 40 to 150 psi, and can be operated at much higher speeds for intermittent duty on air at 80 to 100 psi. Exterior feed type valves can be used in hydraulic service at pressures up to 250 psi using air for the pilot medium. Interior feed type valves can be used on oil from 40 to 150 psi at somewhat lower cycling speeds. Valves are available in single and double-solenoid, also lever and single and double-piloted designs. **C. B. Hunt & Sons Inc.**, Salem, O.

Circle 478 on Inquiry Card

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Experimental Stress Analysis

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B.S. to Ph.D. in mechanical engineering with 3 to 5 years' experience in one of these fields essential. These are permanent positions offering an opportunity to use your initiative and creative ability. We offer excellent employee benefits including tuition-free graduate study. For employment application, call CAlumet 5-9600, or write

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ARMOUR RESEARCH FOUNDATION of Illinois Institute of Technology

10 West 35th Street

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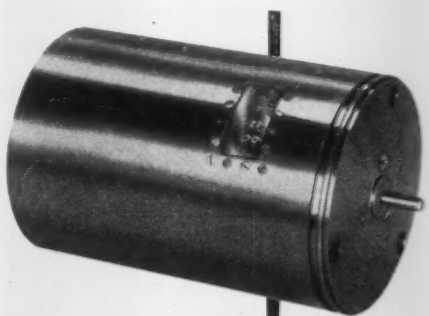
Circle 601 on Inquiry Card



A new sealed, shaft-driven precision AC voltage divider for accurate positioning and calibration.

Gertsch Rotary RatioTran*

100-turn or 1000-turn models available, both in anodized aluminum cases, sealed against dirt and moisture. Ratio is controlled by a single ball-bearing mounted shaft. An internal mechanical counter provides easy readout. Printed silver switches assure long life and reliability.

- High accuracy . . . as good as .005% linearity
- High resolution . . . as good as .0005%
- Low phase shift . . . less than 1'
- High input impedance . . . approx. 50 henrys (200 henrys in 1000-turn model)
- Continuous transient-free output

*TRADEMARK

FOR COMPLETE DATA SHEET, CONTACT YOUR NEAREST GERTSCH ENGINEERING REPRESENTATIVE OR

GERTSCH PRODUCTS, INC. 11846 MISSISSIPPI AVENUE LOS ANGELES 25, CALIFORNIA

Circle 602 on Inquiry Card

catalogs and literature

Latest automaton information. For copies use card page 17.

Industrial DC Use

General Electric Co., Direct Current Motor & Generator Dept., Erie, Pa.—32-*page catalog*—"Why D-C?" is the title given to catalog which discusses the place of dc equipment in industry today. The ability of a dc drive to control almost any production process and its resultant use in automatic systems is covered. Among application areas for dc drives discussed are: Controlling or adjusting sheet tension; matching speeds of different sections, such as in paper machines, conveyors, etc.; controlling acceleration or deceleration; and frequent starting and stopping. Application photographs illustrate the text.

Circle 479 on Inquiry Card

Continuous Flow Conveying

Mathews Conveyer Co., Ellwood City, Pa.—32-*page catalog*—Photographs illustrate applications of various conveyor types for which installation information is given in Catalog 856 on continuous flow conveying. Roller, wheel, belt, live roller, chain, overhead trolley, elevating, spring-mounted roller and portable power conveyors are the types shown. Also illustrated are sheet metal and roller spirals, ball transfers, and special handling machinery such as pallet loaders, coil upender and check-out belt.

Circle 480 on Inquiry Card

Digital Computers

Logistics Research Inc., 141 *S. Pacific Ave., Redondo Beach, Calif.*—8-*page bulletin*—ALWAC III-E is name given to general purpose, electronic digital computer described in bulletin. Computer can store and obey sequences up to 16,000 instructions, and can add, subtract, multiply and divide. Applications, features and operation of the computer are covered.

Circle 481 on Inquiry Card

Terminal Block Equipment

Curtis Development & Mfg. Co., 3266 *N. 33rd St., Milwaukee* 16, *Wis.*—8-*page bulletin*—Fifteen different types of terminal blocks are illustrated and described in Catalog No. 556. Each type is designed for a specific application requirement. Also covered are four types of terminal block kits for experimental work, emergency jobs and general maintenance installations.

Circle 482 on Inquiry Card

Dehydrating Equipment

Davenport Machine & Foundry Co., Davenport, Iowa—12-*page bulletin*—Continuous presses, steam tube dryers, hot air dryers, direct fire dryers, rotary air and water coolers, and atmospheric drum dryers are illustrated and described in bulletin. Various models of machinery used in the dewatering, drying or cooling process for semisolid products are shown, and their specifications given.

Circle 483 on Inquiry Card

Electrical Indicators and Sorters

Simpson Electric Co., 5200 *W. Kinzie St., Chicago* 44, *Ill.*—87-*page catalog*—Divided into sections on panel meters and test equipment, comprehensive Technical Manual 17 is thoroughly illustrated with photographs, wiring diagrams and dimensioned drawings. More than 800 types of panel meters are described in the first section; capacitor testers, oscilloscopes, battery testers, line quality testers, multirange volt-ohm milliammeters, temperature meters, instrument carrying cases and other accessories are covered in the second section.

Circle 484 on Inquiry Card

Permanent Magnet

Magni-Power Co., Dept. 3, *Wooster, O.* — 16-*page booklet* — Photographs, dimension drawings and charts on industrial magnetic equipment such as plates, sweepers, separators, drums and pulleys, grids, troughs and filters are included in Bulletin No. 156. Specialized devices such as textile, magnetic racks, offsets and adapters, plastic, roller channels, etc. are also illustrated and described.

Circle 485 on Inquiry Card

Hopper-Fed Set Screws

Set Screw & Mfg. Co., Bartlett, Ill.—28-*page catalog* — Hopper-fed set screws and hopper feeding mechanisms are illustrated in Catalog No. 21. Other standard and special types of set screws designed to meet conditions of vibration; close precision setting; resistance to tampering, chemicals or heat; and need for increased holding power are also described. Thread data and weights per 100 are given in reference tables.

Circle 486 on Inquiry Card

Enclosed Conductor Systems

Insul-8-Corp., 1369 *Industrial Rd., San Carlos, Calif.*—32-*page catalog*—Safe electrification for cranes, monorail equipment and all moving machinery is provided by enclosed conductor systems described in catalog. Systems are designed for curves, switches, interlocks, gaps and discontinuous control circuits. Installation information, description of components, selection guide and engineering data are included in the illustrated catalog.

Circle 487 on Inquiry Card

Mold and Sand Handling

Newaygo Engineering Co., Newaygo, Mich.—32-*page catalog*—Importance of proper mechanization and automation for efficiency in foundry operations is emphasized in Bulletin 56. Line of sand handling, mold handling and mold making equipment is illustrated and described. Among numerous application photographs are two illustrating automatic cope and drag shakeout.

Circle 488 on Inquiry Card

Rotating Hydraulic Drive Control

Oilgear Co., 1560 *W. Pierce St., Milwaukee* 4, *Wis.*—8-*page bulletin*—Use of all-hydraulic and pneumatic-hydraulic combination controls for rotating drives is described in Bulletin 15011. Illustrations of series-tachometer synchronized drive, parallel-tachometer synchronized drive, mechanically connected hydraulic speed control drive, hydraulically connected hy-

draulic speed control drive, torque controlled drive with unloading valve, and pneumatic-hydraulic controlled drive with unloading valve are included.

Circle 489 on Inquiry Card

Materials Handling Trucks

Lewis-Shepard Products Inc., Dept. 33, Watertown, Mass.—132-*page catalog*—Indexed into five tabbed categories, comprehensive catalog on materials handling trucks includes actual application photographs and specification information. First two sections are devoted to riding-type electric fork trucks and walkie electric fork trucks. Stackers and cranes are covered in another section, with handlift trucks and floor trucks comprising the final two categories.

Circle 490 on Inquiry Card

Packaging Machinery

Peters Machinery Co., 4700 *Ravenswood Ave., Chicago* 40, *Ill*—8-*page bulletin*—Automatic machines for carton forming and lining, carton folding and closing, carton and tray forming and gluing, and folding and closing are described in bulletin. Specifications, operational features, photographs and floor plans showing installation of different packaging machines are included.

Circle 491 on Inquiry Card

Precision Potentiometers

Gamewell Co., Precision Potentiometer Div., Newton Upper Falls, Mass. — 22-*page booklet* — Potentiometer types including metallic and nonmetallic housed precision units, sinusoidal, toroidal, and low-cost models are included in illustrated booklet. Dimensional drawings, specification alternates and power rating curves are also given.

Circle 492 on Inquiry Card

Standard Machine Units

Rehnberg-Jacobson Mfg. Co., 2135 *Kishwaukee St., Rockford, Ill.*—44-*page catalog* — Drilling and tapping units, automatic index tables and screw feed units are described in comprehensive catalog. Company built needle bearing assembly machines and multistation automatic indexing machines using many of the units are also illustrated. Photographs, specifications, machine attachments and application data are included.

Circle 493 on Inquiry Card

Metal Cleaning and Processing

Equipment Div., Magnus Chemical Co. Inc., Garwood, N. J.—34-*page catalog* — Automatic machines for cleaning and bonderizing steel parts, machines which are automatically serviced by means of powered conveyor systems and multistage cleaning equipment are illustrated in Bulletin 10,000-G. Analysis of cleaning problems, selection of chemicals for cleaning and complete line of cleaning machines are discussed. Accessory equipment, heating systems and temperature controls are also pictured.

Circle 494 on Inquiry Card

Mechanical Power Transmission

Revco Inc., 1900 *Lyndale S., Minneapolis, Minn.* — 12-*page bulletin* — Infinitely variable speed reducer called the Zero-Max which features constant torque conversion, and speed variable to zero rpm is described in bulletin. Illustrations of the controller's use in recording oscillograph, coil winder, color proportioner, turning roll, etc. are included. Installation suggestions, dimension and rating tables are also given.

Circle 495 on Inquiry Card

Overhead Cranes

Chicago Tramrail Corp., 1330 *S. Kostner Ave., Chicago* 23, *Ill.*—16-*page booklet*—Push type flexible bridge and hand geared types of underhung type overhead cranes are described in Bulletin U-200-1. Top and side view line drawings for each model, along with dimension tables including I-beam, hanger and wheel

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Circle 603 on Inquiry Card

load data are included. Electrical information on collectors, conductors, controls, motors, reducers and bridge drive is given.

Circle 496 on Inquiry Card

AC and DC Solenoids

Comar Electric Co., 3349 Addison St., Chicago 18, Ill.—6-page pamphlet—Photographs, performance charts and size and mounting data on solid frame solenoids—ac and dc, and laminated ac solenoids are included in Bulletin No. 200. Eight models, for both continuous and intermittent duty, are covered.

Circle 497 on Inquiry Card

Analyzers and Recorders

Hays Corp., Michigan City, Ind.—4-page pamphlet—Combustion meter, a CO_2 recorder which analyzes all types of flue gas, is the subject of pamphlet 56-553-1. Operation and installation data on the meters are given, along with specifications for various available models.

Circle 498 on Inquiry Card

Magnetic Clutches

I-T-E Circuit Breaker Co., 19th & Hamilton Sts., Philadelphia 30, Pa.—4-page pamphlet—Developed to connect or disconnect a driven shaft or gear from a driving shaft while the shaft is moving or stationary, Electro clutch is described and illustrated in pamphlet. Application photographs and comparative size chart are included.

Circle 499 on Inquiry Card

Vibration Monitors

Beta Corp., P. O. Box 8625, Richmond 26, Va.—4-page pamphlet—Line of malfunction detectors which control and protect all types of rotating equipment is illustrated and described in Bulletin 500-1A. Monitors are used in pumps and motors, compressors, generating equipment, turbines, etc.

Circle 500 on Inquiry Card

Production Kits

Alden Products Co., Dept. DS 7, Brockton, Mass.—4-page pamphlet—"Ideas, Techniques, Designs" is title of pamphlet which discusses system of pulg-in unit construction. Photographs and information on two kits comprised of components to mount, house, fasten, connect and monitor electronic circuitry are included.

Circle 501 on Inquiry Card

Automatic Data Logger

Fischer & Porter Co., 618 Jacksonville Rd., Hatboro, Pa.—4-page pamphlet—Designed for a pulp and paper corporation, automatic data logger and control system is described in Bulletin 90-130-24. System is capable of recording up to 200 inputs from process variables. Description of the system and functional diagram of the plant are included.

Circle 502 on Inquiry Card

Transmitting Potentiometers

Manning, Maxwell & Moore Inc., Industrial Controls Div., Stratford, Conn.—4-page pamphlet—Amplifier which is used to convert low level dc millivolt signals to a proportional high level output signal for transmission is described in Bulletin MTT-810. Two models of Series 184 transmitting potentiometer are described, and their specifications are given.

Circle 503 on Inquiry Card

Temperature Regulators

A. W. Cash Co., P. O. Box 551, Decatur, Ill.—4-page pamphlet—Self-operating device which is designed to regulate steam, water and gases is the subject of Bulletin No. 500. Temperature regulator is used on plating tanks, dryers, metal parts washers, and for brine circulating and process cooling systems.

Circle 504 on Inquiry Card

Fast Acting Valves

Humphrey Products Div., General Gas Light Co., Kalamazoo, Mich.—4-page pamphlet—Three-way, multipurpose quick-dump valves which feature fast retraction action are described and illustrated in pamphlet. Pressure operated valves for air, oil, water or freon are available in several models, eight of which are illustrated.

Circle 505 on Inquiry Card

Electronic Tracer Control

Pratt & Whitney Co. Inc., Charter Oak Blvd., W. Hartford 1, Conn.—4-page pamphlet—New device called the Velvetrace Kellering Attachment which is designed for copying intriforms in metal without touching the model is the subject of illustrated pamphlet. Attachment can be adapted to most milling machines or any other machine having a horizontal work table, longitudinal and cross feed motions.

Circle 506 on Inquiry Card

Voltage Speed Control

Century Electric Co., St. Louis 3, Mo.—4-page pamphlet — Selective speed drive comprised of a control station, power unit and dc drive motor is described in pamphlet. Control features, cabinet construction details and photographs of various models are included.

Circle 507 on Inquiry Card

Control Valves

Valvair Corp., 454 Morgan Ave., Akron 11, O.—6-page pamphlet—Single and double - solenoid control valves designed for service with air, hydraulic oil, water or vacuum are described in Bulletin SK356. Cutaway photographs illustrate operation of valves; service and pressure range chart is included.

Circle 508 on Inquiry Card

File-Computer Application

Remington-Rand Univac, Div., Sperry Rand Corp., 315 Fourth Ave., New York 10, N. Y.—4-page pamphlet—Complete stock records for all commodities in several warehouses are kept on high speed magnetic drums by file computer described in pamphlet TM-998. Photographs of system and other data processing units are included.

Circle 509 on Inquiry Card

Automatic Quenching Tanks

American Gas Furnace Co., Elizabeth, N. J.—4-page pamphlet—Designed for use with company continuous production reciprocating hearth furnaces and rotary retort furnaces, continuous automatic quenching tanks are described in Bulletin 820.10. Specifications, water and oil quench modifications, oil cooling and other features of the tanks are covered.

Circle 510 on Inquiry Card

Machine Tool Switches

R. B. Denison Mfg. Co., 102 St. Clair Ave., N. W., Cleveland 13, O.—4-page pamphlet—Seven models of heavy duty limit switches with 19 different contact arrangements are covered in Bulletin 356. Switches are used in the automotive, electrical, metalworking, machine tool and metal product fields.

Circle 511 on Inquiry Card

Air Gaging

Taft-Peirce Mfg. Co., Woonsocket, R. I.—4-page pamphlet—Actual applications of air-electric gaging devices are illustrated and briefly described in pamphlet. Examples of CompAIRamatic gaging cylinder bores, separating sizes, inspecting components, and providing feedback signals to keep parts in tolerance are included.

Circle 512 on Inquiry Card

Precision Potentiometers

Waters Mfg. Inc., 4 Gordon St., Waltham, Mass.—4-page pamphlet—Series of precision wire wound potentiometers with bushing or servo-mounts, and with resistances ranging from 10 to 10,000 ohm is described in illustrated pamphlet. Mechanical

and electrical specifications, resistance ranges, linearity, and other information on the devices are included.

Circle 513 on Inquiry Card

Read and Record Heads

Librascope Inc., 808 Western Ave., Glendale, Calif.—4-page pamphlet—Used for airborne data handling systems, computer memory systems and laboratory storage systems, read and record heads and magnetic drums are the subject of illustrated pamphlet. Specifications and photographs of the devices are included.

Circle 514 on Inquiry Card

Pivoted Bucket Carriers

Hapman Conveyors Inc., Div., Hapman-Dutton Co., Kalamazoo, Mich.—6-page pamphlet—Designed to provide safe mechanical handling of wet or dry bulk materials, pivoted bucket carriers are described in Bulletin HB-854. Automatic direct loading and automatic unloading features are discussed; application photographs are also included.

Circle 515 on Inquiry Card

Compression Molding

Automatic Molding Machine Co., 3217 Exposition Place, Los Angeles 18, Calif.—4-page pamphlet—High speed, fully automatic molding machine for any fast curing thermosetting material is described in pamphlet. Specifications of Models A50 and A25 are given, along with illustrations of the machines.

Circle 516 on Inquiry Card

Belt Conveyor Components

New London Engineering Co., New London, Wis.—4-page pamphlet—Directed toward solving materials handling problems, illustrated pamphlet includes pictures of 22 basic belt conveyor supports and undercarriages. Details, specifications and general information on conveyor are given.

Circle 517 on Inquiry Card

Single-Phase Motors

Robbins & Myers Inc., Motor Div., Springfield, O.—4-page pamphlet—All weather, capacitor start motors are described in Bulletin 470-A. Five frame styles for the 10 and 15 hp motors are illustrated. Construction for outdoor installation includes screened end-head openings.

Circle 518 on Inquiry Card

Platen Conveyor

Visi-trol Engineering Co., 9345 Hubbell, Detroit 28, Mich.—4-page pamphlet—Used for assembly, inspection, integrated machining or processing, heavy duty platen conveyor is the subject of pamphlet. Conveyor can be used as an integral unit or as part of an automation line.

Circle 519 on Inquiry Card

Time Delay Relay

A'G'A Div., Elastic Stop Nut Corp. of America, Elizabeth, N. J.—2-page pamphlet—Two types of time delay relays—one for operation on energization and the other for operation on de-energization — are discussed in pamphlet SR-6R. Photographs, specifications and general descriptions of the relays are included.

Circle 520 on Inquiry Card

Machine Circuits

Machine Tool Electric Corp., P.O. Box 1267, Lansing, Mich.—4-page pamphlet—Electrical circuits for automation of new and old machinery are discussed in Bulletin No. MC601. Machine mounting cabinets, cubicles, control panels and floor installations are among types of custom wiring components discussed.

Circle 521 on Inquiry Card

Limit Switches

Furnas Electric Co., 1128 W. McKee St., Batavia, Ill.—4-page pamphlet—Used to control the movement of doors, conveyors, machine work tables or carriages, line of limit switches is the subject of Bulletin No. 5605.

Circle 522 on Inquiry Card

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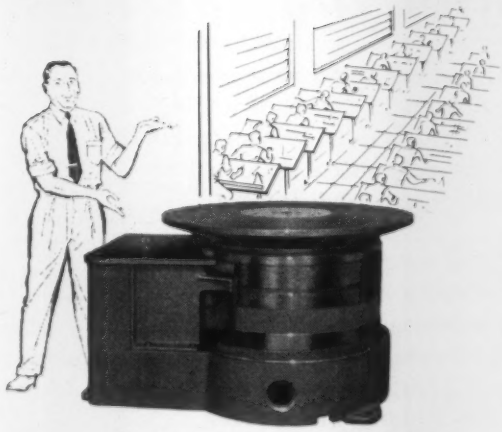

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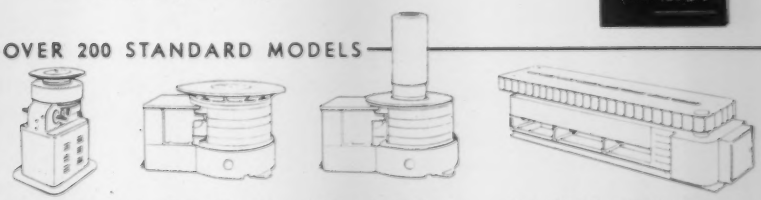

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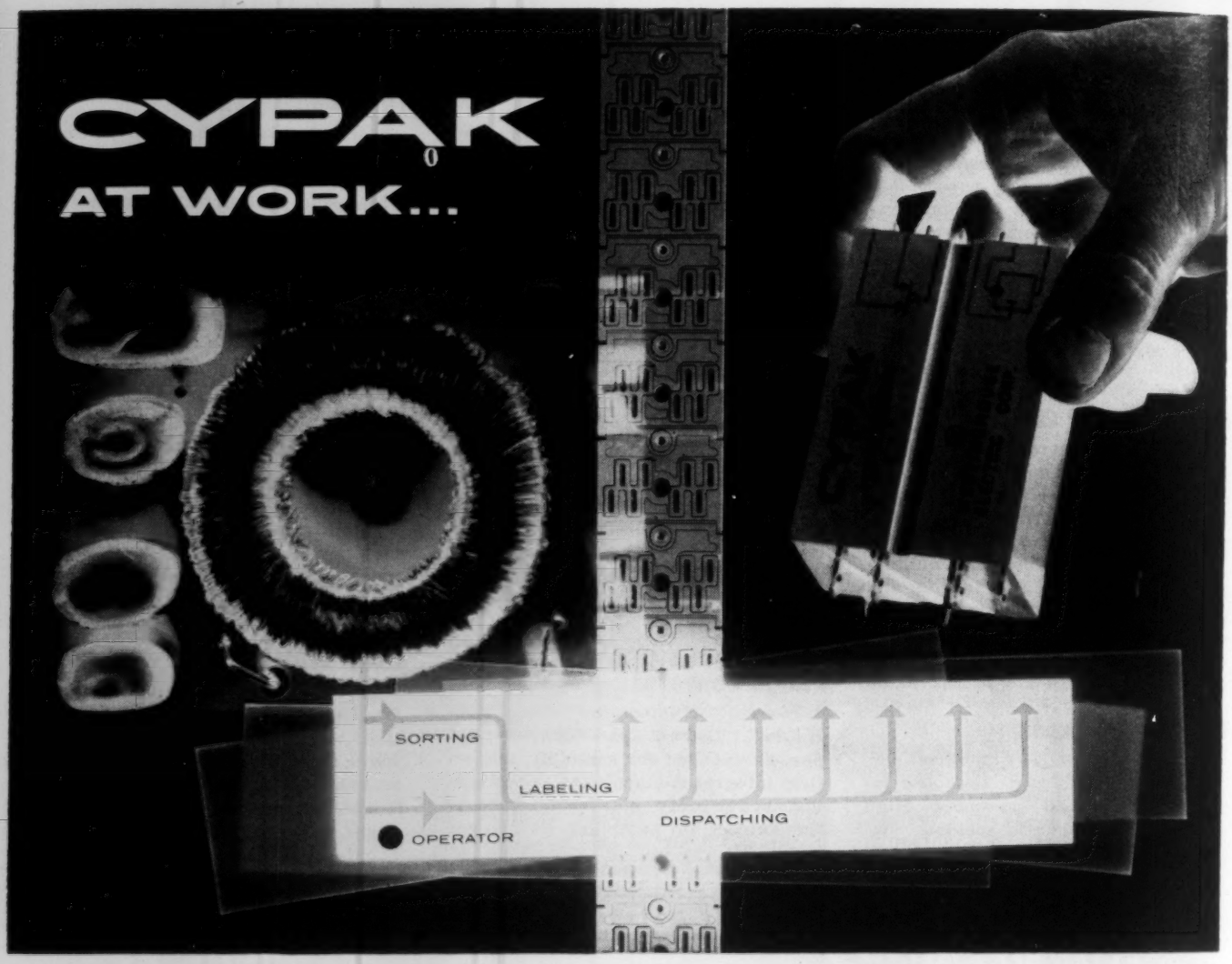

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Circle 605 on Inquiry Card

AUTOMATION abstracts

INSTRUMENT CONTROL OF POWER PLANTS

By P. S. Dickey
President
Bailey Meter Co.

STEAM-ELECTRIC power plants built prior to World War II generally used separate control centers for the load dispatcher, the turbine room, the boiler room, and the pump and heater area. With the advent of the single boiler-single turbine generating unit, which was adopted just before World War II, the common control center for boiler, turbine, and auxiliaries and often for load dispatching was widely accepted. Control centers for operation of one, two and up to four major steam-electric generating units were incorporated into plants built within the past 10 years.

Extensive experience with some 50 million capacity in steam stations provided with centralized control has established without question the following benefits of this design.

1. A substantial increase in power production per operating and maintenance employee utilized.

2. Improved performance during start-up and emergency operation due to better co-ordination of the operating personnel.

With the arrival of the super-critical-pressure steam-electric station using once-through boilers, the boiler, turbine, and feed system are tightly interlocked and the need for a common control center and a co-ordinated control system is greater than ever before.

Automatic Data Handling

While we may expect further refinement in design of control centers for steam-electric generating stations, results with present-day arrangements indicate that we are reaching the point of maximum return in reliability and flexibility of operation and in manpower saving. However, there is another area for instrumentation which is receiving much attention at the present time.

We know that in the day-by-day operation of the steam-electric generating unit there is a substantial variation in the efficiency of boiler, turbine, feed-heating, and condenser systems, and it is often difficult to avoid or to account for these variations.

On large steam-generating units (above 150,000) these relatively small variations in efficiency represent variations in operating cost which would justify considerable capital investment to avoid.

Instrument manufacturers are being forced to the conclusion that commercial instrumentation used up to the present is primarily for the purpose of guiding the operation of the plant. While records are valuable for reference and are of some use in determining plant performance, the basic instrumentation has neither the inherent accuracy nor the proper arrangement for precise performance determinations and for maintenance of highest possible efficiency.

In view of the general acceptance of single boiler-single turbine units and because of interest in economic incremental loading of generating units of an interconnected system, more or less continuous precise determination of unit performance is becoming necessary to augment the use of line-loss penalty factors in

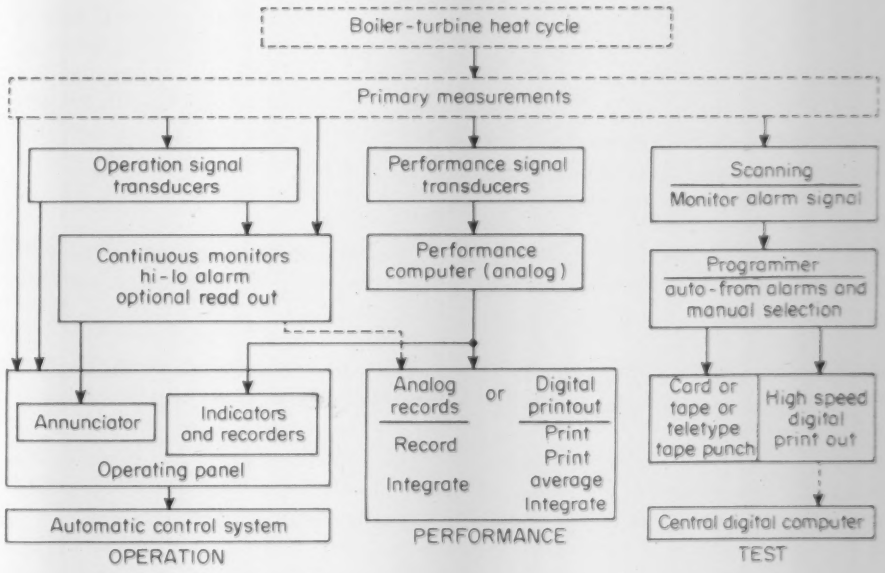

Fig. 1—Schematic instrumentation arrangement for operation, performance and test.

establishing the most economical method of loading generating units on an interconnected system. Potential savings through economic loading are sizable today and will be of far greater importance in the future as unit sizes increase and transmission systems become more complex.

We now believe that instrumentation for the future steam-electric generating station will be split into the three groups shown in *Fig.* 1.

1. The first group will include instrumentation necessary for guiding the operation. It will be designed for maximum reliability and minimum outage and it will be suitable for actuation of the automatic control system. It will include the necessary indicating and recording devices to guide the operator during normal, start-up and emergency operation. It will be a somewhat simplified version of instrumentation used in today's control center.

2. The second group of equipment will include data-gathering and analog-type processing equipment for precise performance determination. The instrumentation will be of the highest possible precision and will be applied in such a manner that it may be easily removed from service for calibration checks to insure that high precision is maintained.

3. The third group of instruments will transmit to scanning devices which may be designed to accomplish any desired objective from simple fault analysis to complete detailed performance testing of major units and/or auxiliaries. Scanning and digital techniques seem best suited to this service because the potential number of readings is large and the programming complex and variable. Since the service is not continuous burden on the scanning and digital conversion equipment is not severe so that reasonable performance without excessive maintenance may be expected.

On the smaller steam-electric generating units, use of the three distinct group of instrumentation has not been practical because the savings are insufficient to justify the cost of including and servicing precision-measuring devices and data-processing equipment so that there has been some sacrifice in performance results presently obtained. However, on the larger units of today and of the future, the potential savings are so great and the advantages as will be outlined so obvious that there seems no question about this being the future pattern.

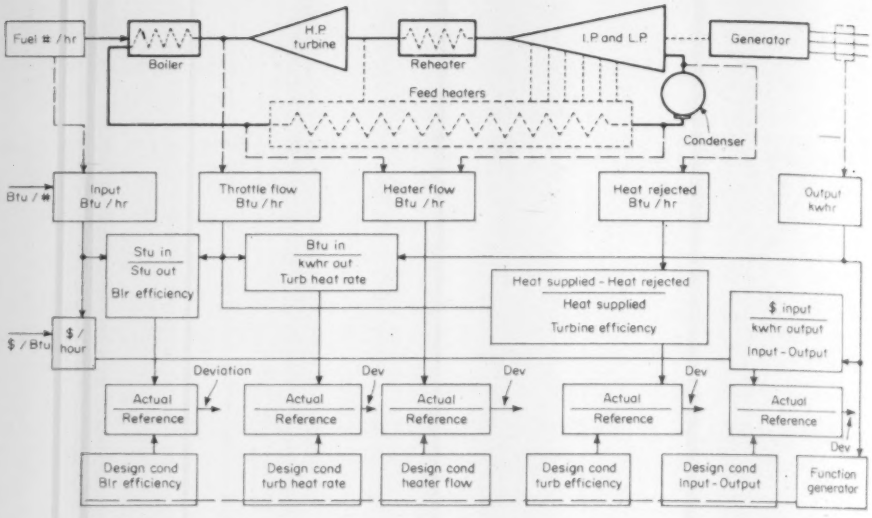

Fig. 2—Simplified diagram for power plant performance instrumentation.

Advantages

The advantages of segregating operating guides and precise performance and test instrumentation are as follows:

1. The control center for large steam-electric generating units with complex auxiliaries can be simplified since the operator will require only continuous indicators or records necessary for guiding him in the reliable operation of the unit. Many of the measurements of temperature, pressure and pressure losses, flows, etc. now used in the control center can be eliminated.

2. Precise performance data will be gathered and processed outside the control center so that the operator will receive only results and pertinent information to guide him in correcting faulty performance.

3. Incremental cost data can be sent continuously and directly to the load dispatcher for economical loading of the system.

4. The data processing equipment will prepare permanent continuous records of output, input and over-all and individual unit performance in a form suitable for direct cost accounting.

5. The need for a large Results Department to collect and interpret data from the plant and the need for extensive and expensive testing programs of major units will be eliminated.

6. Complete test data taken and interpreted continuously during the early stages of operation will lead to earlier correction of design faults and will enable builders to improve their designs on subsequent units.

Application of Data Processing

In the application of data processing to the steam power plant, as in the application of data processing to business operations, the success or failure depends entirely upon development of proper methods, which in the terminology of the computer engineer is called programming. Much further study is indicated before we will know how to design a practical program for determining steam-electric-generator performance. Still further study will be required before we can offer economical scanning and digital-data-processing equipment for fault analysis and detailed testing programs.

For present-day large steam generators, the analog-type performance determination method illustrated on *Fig.* 2 seems to offer

a means of providing information for economic incremental loading and for continuous over-all boiler, turbine, and heater-cycle efficiency records. Equipment utilizing this method can provide continuous accurate performance results at a reasonable cost.

By continuously comparing the measured and calculated performance of boiler, turbine, and feed heaters against design conditions, operating personnel are provided with immediate notice of off-standard operation and with a reasonable amount of properly designed testing equipment can quickly locate the reasons for inferior performance.

It is possible that complete testing equipment using data scanners and digital-data-processing equipment should be portable so that it can be moved from unit to unit to provide information for checking the design of new units during the start-up period and for making periodic detailed performance tests on older units.

On very large units of complex design, a permanent installation of scanning and digital-conversion equipment may be justified to permit frequent detailed testing programs to be carried out quickly and at a minimum of expense.

Continued Progress

In this twentieth century the engineer has made great progress in extracting the maximum amount of useful electric power from each fuel unit, through the use of high pressure and high temperature, and of larger steam generators of improved thermodynamic and mechanical performance. Intelligent use of instruments and automatic control has helped to operate these complex machines effectively and reliably and has helped to provide the information for further improvement in design. The pattern of progress outlined herein will be continued for years to come.

From a paper entitled, "Instruments and Control—Key to Economical Performance of Steam Power Plants" presented at the Fall Meeting of the American Society of Mechanical Engineers in Denver, Sept. 1956.

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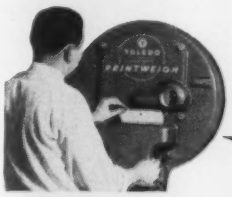

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Circle 606 on Inquiry Card

MATERIALS HANDLING TRENDS

By Wilfred V. Cosgrain
President
Mechanical Handling Systems, Inc.

WITH THE ENDING of World War II, industry found itself faced with a tremendous pent-up demand for consumer goods and semidurables. Nearly everybody was in the money, and wanted goods fast —automobiles, household appliances, new homes, clothes, and all the other items they could afford and some they couldn't afford. At this time the production machine was prepared to meet the challenge. Manufacturers knew how the great outpouring of goods coud be achieved, through a wider use of machinery, particularly material handling equipment.

Let us here review broadly some of the trends that have been going on from the standpoint of the materials handling equipment industry. The mechanization of handling must be an integrated feature if optimum results are to be achieved. The purpose of all mechanization, and especially of materals handling equipment, is to increase the value added per worker. To put it another way, it is to reduce the manual handling of materials as close to zero as practical. This is being accomplished in many ways.

The Picture Today

For example, let us consider the mounting of tires on wheels in an automobile factory. Methods for doing this job automatically have been developed which increase production 250 per cent with 75 per cent fewer employees. Tire plants have automatic dispatch systems with monorail trains operated by means of dialed instructions on the train controls.

Completed automobile frames are handled automatically through finishing, painting, and inspection, the only attendant being a combined operator - inspector. In freight terminals tow line conveyors move goods with ease, cutting terminal labor costs by as much as 50 per cent. Fork trucks move in to remove the loads without halting the steady flow of the tow line.

Manufacture of household appliances such as washers, dryers, ranges, refrigerators and the like is conveyorized to a high degree, even to the point where some assembly operations have been made automatic. On a mery-go-round type of conveyor 9 operators build 162 electric washer harnesses per hour. Formerly it took 19 operators to turn out only 65 harnesses per hour. As washing machines are assembled the line moves parallel to another conveyor carrying testing instruments at the same speed. Each washer is given an opertion check without slackening the production flow.

The warehouse, too, where delivery conveyors from 5 different manufacturing units converge, is highly mechanized. Here a single operator sits at a control board and automatically handles all the production flow. Appliances come in on live roller conveyors in batches, with each batch comprising a single model and color. Working from coded order sheets, the dispatcher pushes buttons and sends groups of appliances toward the proper loading station in the proper order. Without confusion, the conveyor, elevated 30 feet in the air, moves the appliances toward their destination, where they descend to waiting fork trucks.

How Far Can We Go?

Just how far can we go toward reducing manual handling to zero? In theory we can go all the way, since our engineers have the equipment and the know-how to make all handling mechanical. The degree to which this mechanization will be carried depends, as it has in the past, on economic considerations. Despite the great publicity given to mechanical handling and automated production, a close scrutiny will reveal that the truly automatic factory still is yet to come, while the mechanization of an entire industry is even farther away. We estimate that even in the highly mechanized automobile industry mechanical handling of parts has been carried to only about 75 per cent of the ultimate, whereas so-called new automation has not penetrated to more than 10 per cent of its potential field.

Having no occult powers, our look into the future will necessarily be somewhat speculative, though of course it will be strongly influenced by present trends. Combined sales in the materials handling industry, embracing all the various activities which go to make it up, were in 1955 about $1½ billion and conveyor sales were approximately $300 million. Based on a projection of present trends and using forecasts from reliable sources on probable trends in plant and equipment expenditures, and based on the assumption of no unforeseen difficulty, it seems reasonable to speculate that overall sales in the materials handling industry by the end of the next 10 years will total $2½ billion annually, and that conveyor sales will be made at the annual rate of $500 million. This forecast is made on the basis of today's dollar.

What to Expect

Now let's look briefly at some of the technological advancements by which this new goal may be achieved. We can expect that within the next 10 years automation will reach the point where electronic computers will forecast market trends and arrive automatically at a production schedule to meet the anticipated market. The computer will then relay the desired production schedule to the automatic production system. Materials will begin to move in on conveyors automatically for processing. As they are transported along they will also be subjected to complete quality control. If needed, they will be weighed, sorted and classified.

As components are fabricated and assembled they will move on conveyors to banks located at strategic intervals along the sub and final assembly lines. At no time will any operation be forced to shut down because of a shortage

of parts. Should any one processing machine, or even a series of machines, be forced to shut down for maintenance and repairs, this one-time bottleneck will be circumvented and a steady flow of materials automatically diverted from conveyor banks.

Automatic Warehouse

Moving into warehousing and distribution, it is our opinion that the application of material handling will become as complete as in production. The automatic warehouse probably will work in this fashion: Bins and bays will be organized as a gigantic automatic filing system. Stocks will be arranged either on storage conveyors or on specially designed racks.

Orders will be assembled by pushing buttons at central control panels. Automatically the required items will move onto a delivery conveyor. Say the order is for ranges. At the dock they will be assembled in a pigeon-hole group of racks corresponding in size to a similar rack arrangement on waiting delivery trailers. In one movement the appliances will slide from the dock pigeon-holes into those on the trailer. At the distributor's warehouse the order will tilt off into a matching conveyor rack which moves inside mechanically. Warehouse conveyors will be arranged in a series of loops so that dispatch can be made to any corner.

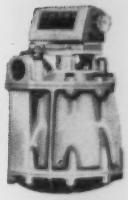
The great American march to emancipate labor continues. Our development and use of mass production techniques has raised the living standards of the American worker to heights far above his counterpart in any other place in the world. We can take pride and satisfaction in the knowledge that we have brought the good life to the common man. We can sum up the spirit that keeps it moving by saying that in industry, as well as in romance, the world belongs to the young at heart.

From a paper entitled, "Future Trends and Developments in the Materials Handling Industry" presented at the annual Washington Conference of Machinery and Allied Products Institute, Washington, D.C., June, 1956.

BOWSER
ESTABLISHED 1885

METERING 1

Bowser meters with ticket printers provide accounting records of liquid receipts, transfers and deliveries.



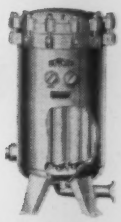
CUTS COSTS 3 WAYS

CONTROLS INVENTORY

Perpetual inventory and accurate control of process liquids in plant pinpoints profitable operation.

FILTERING 2

Bowser filters of all types are available for filtration of nearly every process or industrial liquid.

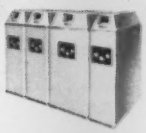


IMPROVES QUALITY

Uniformity of color and clarity with better quality control assures efficient processing of finer end-products.

BLENDING 3

Bowser blenders proportion and combine any number of liquid components in a continuous, closed system with highest accuracy at pumping flow rates.



SAVES MAN-HOURS

Hand "batching" is eliminated. Push-button control automates production to cut costs, improve profits.

Write for "DIGEST"

Bowser "liquid automation" equipment is available on lease or progressive payments to conserve working capital.

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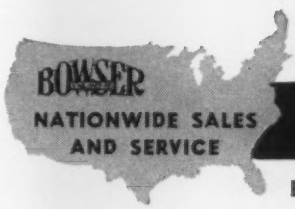

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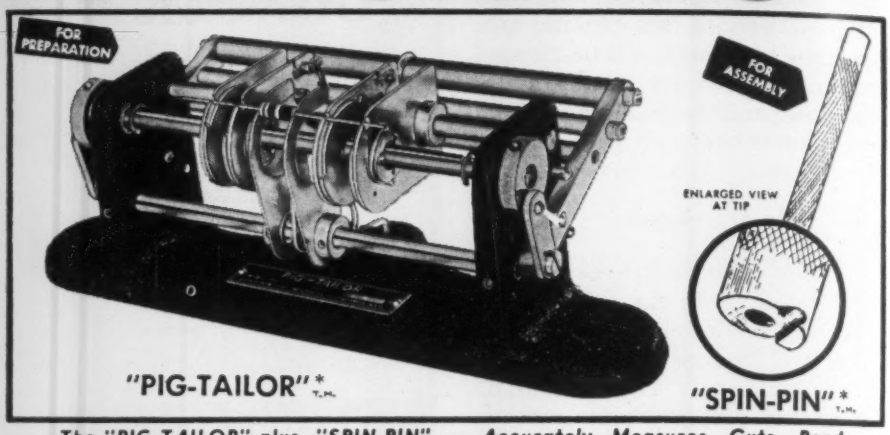

The "PIG-TAILOR" plus "SPIN-PIN" — Accurately Measures, Cuts, Bends, Ejects and Assembles both leads simultaneously to individual lengths and shapes — 3 minute set-up — No accessories — Foot operated — 1 hour training time.

PIG-TAILORING provides:

1. Uniform component position.
2. Uniform marking exposure.
3. Miniaturization spacing control.
4. "S" leads for terminals.
5. "U" leads for printed circuits.
6. Individual cut and bend lengths.
7. Better time/rate analysis.
8. Closer cost control.
9. Invaluable labor saving.
10. Immediate cost recovery.

PIG-TAILORING eliminates:

1. Diagonal cutters.
2. Long-nose pliers.
3. Operator judgment.
4. 90% operator training time.
5. Broken components
6. Broken leads.
7. Short circuits from clippings.
8. 65% chassis handling.
9. Excessive lead tautness.
10. Haphazard assembly methods.

* PATENT PENDING

Write for illustrated, descriptive text on "PIG-TAILORING" to Dept. A-11P

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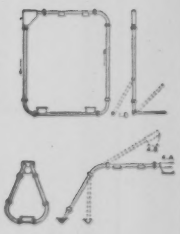
Examples of a few typical circuit plans.



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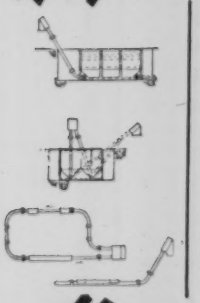

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AUTOMATION
PENTON BUILDING, CLEVELAND 13, OHIO

AUTOMATION patents

Copies of patents are available at 25 cents each from the Commissioner of Patents, Washington 25, D. C.

Handling

CODING, DECODING AND CODE SENSING MECHANISMS FOR SORTING APPARATUS

Articles being sorted are carried on conveyor system by holders which incorporate sensing and indicating elements. These elements actuate transfer means to direct holders to suitable branch conveyors. Patent 2,751,092 by Robert Gourdon, assigned to Societe Anonyme dite: Centre d'Etudes M.B.A., Paris, France.

CONTINUOUS FEED MECHANISM

Circular workpieces are elevated from a hopper by an endless conveyor having sloping channels. Parts roll from the channels into a reservoir which feeds a discharge duct. Speed of the conveyor is regulated in relation to the level of parts in the reservoir. Patent 2,745,537 by Harold O. Cadman, assigned to Gardner Machine Co.

APPARATUS FOR SEPARATING AND FEEDING ARTICLES

Machine changes series movement to substantially parallel transverse movement. Transfer is affected by means of air jets triggered by light-sensitive cells. Patent 2,744,609 by Ray S. Jenney, Robert T. Fetherston, and Glen R. Miller, assigned to Kellogg Co.

♦ ♦ ♦

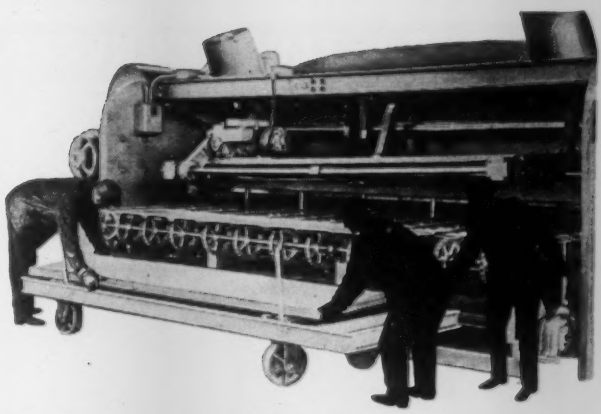
Process Design

CONTINUOUS HORIZONTAL HOT MOLTEN METAL CASTING APPARATUS

Single integral article is cast by pouring into mold sections carried by a horizontal conveyor in such manner that a continuous mold is formed. Patent 2,751,647 by Benjamin Brownstein.

BLANK AND METHOD FOR MAKING INTEGRALLY STIFFENED AIRCRAFT SKIN

Metallic sheet integrally stiffened by parallel ribs can be made by extruding a hollow polygonal shape, slitting the extruded product and flattening the result into a desired sheet. Patent 2,742,692 by Karl F. Braeuninger, assigned to United States of America.



One man, using this FRIED LIFTVEYOR and a FRIED STRIP-STACKER,

cuts and stacks 40% more sheet metal

than a shear operator working with two manual helpers

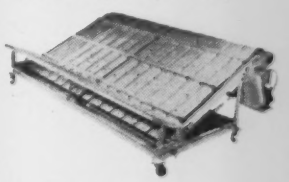
—reports A. R. Purdy Co., prominent metal warehouse

Mechanized operation eliminates extra men formerly needed for handling wide sheet; shears worked at capacity for first time; safe operation assured.

When A. R. Purdy Co., Inc., leading New Jersey metal warehouse, found that 2 back shear assistants could not keep pace with the 60-strokes-a-minute rate of their 3 shears, they installed a FRIED LIFTVEYOR and 2 FRIED STRIPVEYORS.

"Almost immediately," says a Purdy official, "our production increased to the maximum of each shear" *(a rise of 40%)*. Furthermore, "we no longer need 2 men behind the shear!"

Purdy shearmen find that their FRIED LIFTVEYOR'S pneumatically operated plungers provide an effective support against flexing for all types of metal, all sheet widths. Any gauge steel, stainless, aluminum and bronze sheets are easily supported, then sheared within .005 of an inch.



The FRIED STRIPVEYOR handles the cut strip *automatically*, carrying the metal safely beyond the shear bed. Combined with a FRIED STRIP PACKER, the STRIPVEYOR raises the strips to the desired point, dropping them on to the STACKER.

"In adding this equipment," says the Purdy company, "we have for the first time completely mechanized our shearing operations and made it possible to work our shears to their capacity and produce quality products with safety to our men."

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AUTOMATION

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Thirty-four leaders review past, present and future aspects of standardization and its impact and effect. Two brief chapters specifically discuss relationships between standards and automation. References are given at the end of individual chapters. Notes on standardization in all types of commercial areas and industries are included.

PULSE AND DIGITAL CIRCUITS

By Jacob Millman, professor of electrical engineering, Columbia University and Herbert Taub, associate professor of electrical engineering, City College of New York; 687 pages, 6 by 9 inches, illustrated, clothbound, published by McGraw-Hill Book Co. Inc., New York; available from AUTOMATION; *$12.50 postpaid.*

Comprehensive basic text covers components, circuits and techniques beyond the long standing emphasis on electronics for radio engineering. These broader concepts must be applied for work in the modern fields of control systems, data-processing systems, nucleonics, telemetering, etc. Circuits are analyzed on a physical basis with mathematics being used after physical motivation is discussed. Over 400 helpful problems are included.

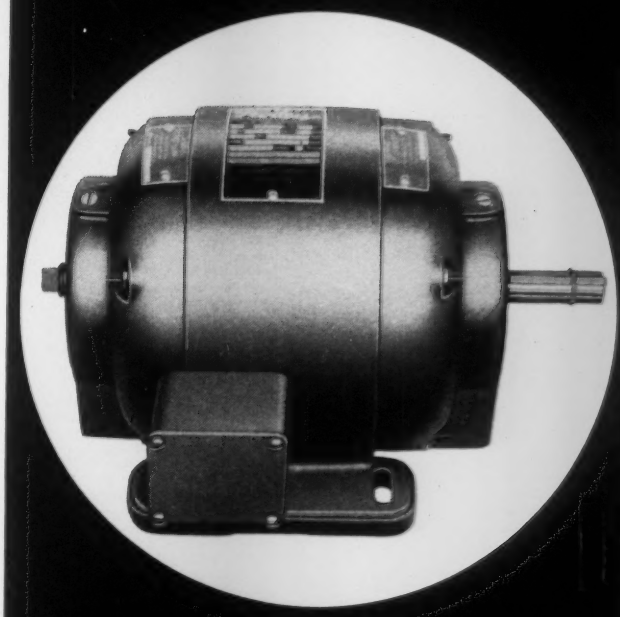
Industrial Publication

REPORT ON FIRST ANNUAL CONTOUR MACHINING CONFERENCE

Paperbound, 24 pages, 8½ by 11 inches; available from True-Trace Corp., 9830 E. Rush St., El Monte, Calif.; Free.

Illustrated texts of five papers, and report of panel discussion covering use and tooling of tracer control machines, their accuracy, and experiences of various users. The conference was sponsored by True-Trace Corp. with the co-operation of Consolidated Vultee Aircraft Co., Douglas Aircraft Co. Inc., Consolidated Engineering Corp., Farnum Mfg., North American Aviation Inc., and Northrop Aircraft Inc.

MARINE



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CUMULATIVE EDITORIAL INDEX

Including six issues. Number preceding the hyphen is month of issue; those following are page numbers in that issue.

A

Acceleration, dc motors, 6-82
Air, use of compressed, 9-43
Alder, S. M.
Magnetic Memory Controls Distribution Conveyor, 7-69
Aluminum,
anodizing, 6-66
melting, 6-66
Analog
information, 10-84
systems, 10-137
to digital converter, 6-19
Analysis,
electric circuit, 8-122
gas stream, 11-78
Analyzers, continuous, 8-49
Anodizing, 6-66
Antonson, W. L.
Photoelectric Control In Log Handling, 11-58
Assembly, 6-12, 17; 10-50
auto wheels, 9-40
automated, 10-50; 11-63
circuit board, 10-68
continuous, 11-63
cyclic, 11-63
electronics, 10-19
Astin, A. V.
Industry Needs Automation, 9-133
Automatic multispindle machine tools, 6-49
Automation,
and government, 7-28
and industry, 7-28
and labor, 7-28
and the public, 7-28
and smaller plant, 10-63
and stockholder, 7-28
apprenticeship program, 7-19
controllers, 9-54
developments needed, 9-133
effects of, 6-142
machine tool field, 8-66; 10-63
philosophy, 6-12, 46; 7-28
planning for, 7-28
welding field, 11-33
Automobile parts manufacture, 8-55
Automobile wheel assembly, 9-40
Award, editorial, 6-11

B

Bakery, handling, 6-24, 32, 34
Balancing,
automatic, 9-71
flywheels, 7-13
Ballizing, 10-75
Barrel finishing, 6-142
Batch processing, 6-58; 11-81
Baughman, G. W.
Automatic Operation of Railroads, 8-116
Bearings,
antifriction valve, 9-70
synthetic fiber, 7-13
Beer-case handling, 8-37
Belt feeders, 7-37
Binary, operation, 6-60
Black, D. V.
Bibliography of Literature on Computers, 11-135
Boiler water corrosion, 9-12
Bolz, R. W.
At the Crossroads, edit. 11-43
Bonding linings, 11-78
Braking, dc motors, 6-82
Broaching, 11-48
Bronze, continuous casting, 7-42
Brown, J. J.
Potential in Canada, 10-142
Buchsbaum, W. H.
Automation Right Now, 6-46
Bulk weighing, 8-44
Burgoyne, A. S.
Synchronizing Sensing and Processing, 9-49
Bus bars, 6-16

C

Cable conveyors, 6-76
Cameras, 8-16
Canada, automation in, 10-142
Carbon paper manufacture, 6-46
Carrier equipment, remote control, 9-66
Casgrain, W. V.
Materials Handling Trends, 11-126
Casting, continuous, 7-42; 11-129
Ceramics, spray system, 8-20
Chemical,
analysis, 11-25
handling, 6-28
pneumatic & electronic controllers, 9-54
processing, 8-49
Chip removal, 6-21
Circuits,
design, 11-131
preferred, 7-49
self-checking, 8-10
standardized, 6-11; 7-49
telephone, 11-50
tester, 6-19
Cleaning, 7-52
Closed-loop systems, 7-56
Coal handling, 6-28, 37
Coffee dispensing machine, 6-12
Coffman, P. A., Jr.
Controlled Feeding For Liquid And Dry Materials, 7-37
Coil, stock processing, 6-77
Coining, 11-64
Combes, J. J.
Continuous Analysis Key to Improved Processing, 8-49
Components, 6-138; 8-30
electronic, insertion, 10-68
Compressed air use, 9-43
Computers, 6-134; 10-22, 137
and management, 8-122
bibliography on, 11-135
Computing, mix proportions, 10-62
Container, self-feeding, 7-20
Contents, 11-3
Continuous melting furnace, 6-65
Continuous processing, 6-58
of fiberboard, 6-68
Continuous stream processing, 8-49
Continuous strip processing, 6-46, 77
Contour forming, 8-41
machining, 11-131
Control, 6-138; 7-55; 8-120
aircraft throttle, 8-19
bulk feeders, 7-37
chemical processes, 8-49
computers, 10-137
conveyor, 7-69; 8-37; 11-58
cutoff operation, 10-74
dc drive, 8-60
digital, 9-130
electronic, 6-46
feedback systems, 6-60, 77, 142
finishing process, 11-57
flow ratio, 11-80
food packaging, 9-46
grinding operation, 8-13
machine, 9-71
machine tools, 8-66; 9-12, 130; 10-137; 11-73
milling, 6-60
moisture, 9-9
numerical, 6-60; 9-130; 10-84
of railroad, 8-116
overhead crane, 9-10
pH, 9-78
photoelectric, 8-41; 11-58
positioning motors, 11-71
process, 6-52; 7-46
punched card, 11-81
rolling mill, 11-9
self checking, 8-10
solid state, 7-113
speed, 8-110; 10-90
strip processing, 6-77
system design, 8-122
tape, 7-66; 8-115
temperature, 8-8; 10-78
template, 8-41; 11-73
thickness, 10-90
water works, 6-46
Controllers, 9-54
moisture, 9-9
Converter, analog to digital, 6-19
Conveying, 8-37
newspapers, 10-59
Conveyors, automatic unload and transfer, 9-44
escapement, 9-41
gravel, 8-12
gravity wheel, 6-50
helicoidal screw, 7-68
light product, 7-61
overhead, 6-25, 30, 38
overhead cable, 6-76
pneumatic, 6-24, 28, 34; 8-44
tiered, 6-58
Corrosion, boiler, 9-12
Counter, for cutoff control, 10-74
Counting, instruments, 6-11
Covered rolls, 6-75
Crane control, 9-10
Current limit, dc motors, 6-82
Cycle, automatic machine, 8-55

D

Data processing, 6-142; 7-10, 11; 8-37; 10-12, 62, 148; 11-9, 15, 16, 78
Data storage, 7-46
Daugherty, J.
Management and Numerical Control, 9-130
Davis, R. E.
Testing Hydraulic Speed Control, 8-110
Dc drives, 8-60
De Carlo, C. R.
Uses of Computers in Production, 6-134
Delays for information, 9-49
Design,
control system, 8-122
electronic, 8-30
hydraulic, 7-23; 10-75
Detector, tear, 6-46
Dickey, P. S.
Instrument Control of Power Plants, 11-123
Differential transformer, 8-13
Digital,
computers, 7-128
control, 9-130
encoder, 9-10
information, 10-84
systems, 10-137
Dispensing, coffee machine, 6-12
Distribution, 6-24
system, 7-69
Drives, dc, 8-60
Dust collection, 11-78

E

Economics, 10-68
Editorial award, 6-11
Electric circuit analysis, 8-122
Electrical,
bus bars, 6-16
circuit tester, 6-19
Electrode positioning, 10-90
Electrohydraulic handling control, 8-55
Electrohydraulic system, 6-73; 10-88, 91
Electronics,
assembly, 10-19
circuit assembly, 10-68
control, 6-46; 9-54
in business, 7-128
modular design, 6-12
process control, 6-52
reliability of, 6-142; 8-30
standardization, 7-49
Electrostatic paint spraying, 8-46
Elevator conveyor, 8-54
Enamel, porcelain, 8-46
Engineering for automation, 8-29
Engineers and automation, 6-41
Engineers,
processing, 11-33
welding, 11-33
Ensign, G. G.
Watch Automation, 6-131
Escapements, 10-50

F

Facsimile reproduction, 11-10
Fastening, 10-50; 11-64
Faulkner, W. H.
Radiation Gaging of Plastic Sheet, 6-77
Feedback, 6-60; 9-130; 10-137
in continuous thickness gaging, 6-77
Feeders, 8-48; 10-50
hydraulic, 6-73
magazine, 6-73
Feeding, 8-25; 11-129
assembly components, 10-50
bulk materials, 7-37
dry foods, 9-46
long parts, 6-49
press brake, 8-41
Fiberboard manufacture, 6-68
Finishing, 8-46; 11-57
barrel, 6-142
Flame hardening, 11-77
Flash removal, 10-83
Flow measurement, 10-20
Flow ratio control, 11-80
Food packaging, 9-46
Food processing, 7-61
Forging, 6-22; 7-68
machining, 9-64
Formulation, 10-62
Foundry,
handling, 6-22, 27
Freezing food items, 7-61
Freight car classification, 11-44
Furnaces,
arc, 7-42
continuous casting, 7-42
continuous melting, 6-65
normalizing, 7-10
Furniture, anodizing aluminum, 6-66

G

Gaging, 6-14, 128; 8-48
for machine tools, 8-66
radiation, 6-77
sheet thickness, 6-77
strip thickness, 11-25
Gas fired furnace, 6-65
Graphite, dies in continuous casting, 7-42
Gravimetric feeders, 7-37
Gravity wheel conveyors, 6-50
Greenley, H. R.
Auto Wheel Assembly, 9-40
Grinding, 11-62
centerless, 6-22
machines, 6-73

H

Handling, 6-21, 139; 7-32; 8-120; 11-129
between presses, 8-55
bulk materials, 11-81
coal, 6-28, 37
conveying, 6-21, 50, 76; 7-69; 8-44, 54
feeding, 6-49; 7-68; 10-50; 11-48, 62, 63
for automated lathe, 10-83
foundry, 6-28
in news plant, 10-59
in plating, 7-52
in press operations, 7-63
logs, 11-58
paper, 6-21, 32, 38
stone, 9-70
Hardening, 11-77
Harder, D. S.
Manufacturing in the Future, 8-115
Heat pump system, 7-9
Heating, without fuel, 7-9
Heinz, W. B.
Electrohydraulic Devices, 10-88
Helicoidal screw conveyors, 7-68
Herchenroeder, L. W.
Numerical Control of Machine Tools, 10-84
Hole finishing, 10-75
Hoppers, 8-25
Horsepower, dc motors, 6-82
Host, J. A.
Basic Transfer Machine, 10-91
Hydraulics, 7-23
control, 8-55
machine tool, 8-12; 10-75
press, 8-41
speed control, 8-110
torque motor, 6-38

I

Indexing, 8-66
Indexing table, 6-73
Information, delays, 9-49
In-motion weighing, 11-44
In-process gaging, 6-128
Inserting, electronic components, 10-68
Inspection, 6-14
Instruments, 9-22
control, 11-123
counting, 6-11
liquid weight measuring, 8-13
radiation gaging, 6-77
Integrated handling, 6-21
Interfloor conveyors, 8-54
Inventory control, 7-10

J

Jaeger, J. J.
Automation Affects Quality Control, 7-116
Johnson, E. C.
Numerically Controlled Milling, 6-60

K

Kendall, G. H., Jr.
Basic Transfer Machine, 10-91
Kendall, G. H., Sr.
Basic Transfer Machine, 10-91
Knitting machines, 6-46
Kraft, W. C.
Aircraft Skin Miller, 11-73

L

Landsness, C.
Automatic Balancing, 9-71
Lawson, A. A.
Insertion of Electronic Components, 10-68
Legal problems, 10-148
Linear programing, 10-148
Load cell system, 11-44
Load surveys, 11-15
Logic circuit, 7-113
Loss-in-weight feeders, 7-37

M

Machine tools,
automated types, 8-66
bar automatics, 6-49
boring, 9-43
broaching, 11-48
control, 8-13; 9-12, 130; 10-19, 63, 84, 137; 11-73
conversion, 11-73
gaging, 6-128
grinder, 6-73
hydraulic, 7-23
hydraulic slotter, 3-12
hydraulic systems, 10-75
lathe, 11-12
milling, 6-60
skin milling, 11-73
tape control, 10-9
tracer control, 11-131
Machines, 8-121
assembly, 6-12
balancing, 9-71
coffee dispensing, 6-12
design, 7-128
food packaging, 9-46
knitting, 6-46
mounting, 7-63
wax making, 6-58
Macmillan, R. H.
Control Systems Simplified, 7-55
Magazine feed, 6-49
Magnetic amplifier, 10-14; 11-71
Magnetic memory units, 7-69
Magnetic tape, 7-69
Magnets, manufacture, 8-48
Maintenance,
electronic, 8-30
support program, 7-10
Management planning, 9-130
Manufacture of,
air frames, 8-41
appliance parts, 8-46
automobiles, 8-25
automobile parts, 6-22 41; 9-43
automobile wheels, 8-55
axle housings, 7-32; 11-33
bread, 7-61
cams, 6-60
camshafts, 6-22
carbon paper, 6-46
circuit boards, 10-68
coil springs, 7-68
compounded chemicals, 8-44
crankshaft forgings, 6-22
dog food, 8-14
fiberboard, 6-68
flywheels, 7-13; 9-71
mercury batteries, 6-12
motors, 6-76; 7-63
office furniture, 6-66
permanent magnets, 8-48
piston pins, 11-62
pistons, 9-43
plastic sheet, 6-77
printed circuits, 8-19
spark plugs, 6-42
stampings, 8-55
toothbrushes, 6-50
transistors, 7-11
TV components, 8-54
valves, 9-64
watches, 6-131
wax cakes, 6-58
Manufacturing prediction, 8-115
Manufacturing research, 8-25
Mater, M. H.
Photoelectric Control In Log Handling, 11-58
Materials,
handling, 8-37, 54; 11-14, 126
McKewen, G. E.
Radiation Gaging of Plastic Sheet, 6-77
Measuring,
liquid flow by weight, 8-13
Melting, continuous furnace, 6-65
Memory units, 7-69; 11-16
Menard, C. G.
Evaluating Machine Tool Arrangements, 8-66
Hydraulic System Improvements, 10-75
Mercury batteries, manufacture of, 6-12
Metering liquids, 11-80
Microscope, in gaging, 6-14
Milek, J. T.
Bibliography of Literature on Computers, 11-135
Milling machine,
numerical control, 6-60
tape control, 7-66
Mixing, dry, 8-44; 10-14
Modular design of electronics, 6-12
Mohler, J. B.
Continuous Casting of Bronze, 7-42
Controlling pH of Process Solutions, 9-78
Moisture controller, 9-9
Monitor vibration, 8-22
Motor,
dc, 6-82
hydraulic or pneumatic 6-38
manufacture, 6-76; 7-63
tape control, 10-19
Muller, D. C.
Magnetic Memory Controls Distribution Conveyor, 7-69
Mullin, W. C.
Automatic Gaging for Machine Tools, 6-128
Murphy, V. R.
DC Drive Characteristics, 6-82
Selection of DC Drives and Controls, 8-60
Muther, R.
Line Production Savings, 6-133

N

Newspaper handling, 10-59
Nitka, N. J.
Testing Hydraulic Speed Control, 8-110
Nothman, G. A.
Tools of Automation, 7-120
Numerical control, 6-60; 9-130; 10-84
Nut-setting, 11-65

O

Office automation, 7-128
Office furniture manufacture, 6-66
Orienting methods, 10-50
Overhead conveyors, 6-25, 30

P

Packaging, 6-21; 8-14; 9-14; 11-78
dry foods, 9-46
Paint spraying, 8-46
Pallets,
handling, 8-54
loading, 8-37
transfer, 10-91
Paper handling, 6-21, 32, 38
Parts selectors, 10-50
Peterson, K. W.
Electronics for Process Control, 6-52
pH,
control of, 9-78
measurement, 9-12
Philosophy,
automation, 6-12
education, 11-20
Photocell,
control, 8-41; 11-58
scanning, 6-46
temperature indicator, 10-78
Pick, M.
Pulse Counter Controls Cutoff, 10-74
Pipe, manufacture, 7-46
Plant layout, 6-133; 7-63
Plastic sheet manufacturing, 6-77
Plating, 7-52
handling, 6-25
Pneumatic,
communication tubes, 8-37
controllers, 9-54
conveying, 6-24, 28, 34; 8-44
feeding devices, 7-68
torque motor, 6-38
Popoli, F. R.
Applying Telephone Switches and Relays, 11-50
Porcelain enamel, 8-46
Positioning, 10-50
control, 11-71
Post-process gaging, 6-128
Presses, 7-32
brake, 8-41
continuous fiberboard, 6-68
Printed circuits, 8-19
Printing newspapers, 10-59
Process control, electronic, 6-52
Process,
controllers, 9-54
design, 11-129
development, 8-25
Processing,
batch and continuous, 6-58
chemical, 8-49
Processing of strip stock, 6-77
Product design, 6-26
Production,
line, 6-133
scheduling, 6-134
Programing, 10-68
Proportioning, 11-80
Pump, chemical resistant, 10-20
Punched cards, 7-13; 10-68
batching control, 11-81
rolling mill control, 11-9
Punched tape control, 6-60

Q

Quality control, 7-115

R

Radiation gaging, 6-77
Radio,
civil defense, 10-9
weather station, 6-15
Railroad, 8-116
car weighing, 11-44
Random processes, control, 10-148
Redner, K. H.
Packaging Dry Food Products, 9-46
Regulation dc motors, 6-82
Relays, electrohydraulic jet pipe, 10-88
telephone type, 11-50
Reliability, electronic, 8-30
Remote control, 6-52; 10-14
via voice frequencies, 9-66
Reproduction, facsimile, 11-10
Research, 8-25
Resistors, temperature sensitive, 9-69
Reynolds, H. L.
Photocells Control Versatile Press Brake, 8-41
Riveting, 11-64
Rolls, covered, 6-75

S

Sampling, chemical, 8-49
Saturable reactors, 11-71
Sawing, fiberboard sheets, 6-68
Scanning, photoelectric, 6-46
Scheduling production, 6-134
Scollard, W. E.
Auto Wheel Assembly, 9-40
Scrap disposal 7-63
Screwdriving, 11-65
Seidel, R. B.
Tailoring Automation To Plant Needs, 10-63
Selection of dc drives, 8-60
Semi-conductor, thermistor, 9-69
Serrating, 6-49
Shipping, 8-37
Small plant automation, 10-63
Smart, W. L.
Porcelain Enamel Applied Electrostatically, 8-46
Solid state controls, 7-113
Solution, pH control, 9-78
Sorting, 8-48; 11-12, 67, 129
Spark plug manufacture, 6-42
Special machinery, 8-29
Speed,
adjustment, 6-82
control, 8-110
Spinning, 11-65
Spline broaching, 11-48
Spray system, ceramics, 8-20
Stadum, C. B.
How to Use Solid State Controls, 7-113
Staking, 11-64
Stamping, 7-32 63; 8-55
Standardization, tooling, 9-43
Standardized circuits, 6-11; 7-49
Standards, 11-131
electrical, 7-128
Statistics, automation, 10-143
Steady state, 8-110
Stone, J. J.
Computers in Machine Tool Control, 10-137
Storage, 6-26
Stud-setting, 11-65
Swartz, D. M.
Management — Sell Automation, 7-28
Switches, telephone type, 11-50
Switching, railroad, 8-116
Synchronization, dc motors, 6-82
System reliability, electronic, 8-30
Systems, control, 7-55; 8-122

T

Tandem operation dc motors, 6-82
Tapes,
control, 6-60; 7-66; 8-115; 10-9
magnetic, 7-11
preparation, 7-66
recording, 11-15
steel control, 8-41
Tear detector, 6-46
Telephone equipment, 11-50
Television, in gaging, 6-14
Temperature,
control, 10-78
movement, 7-11
Testing,
circuits, 6-19
keyboard operated equipment, 7-10
motors, 7-63
speed control, 8-110
vacuum seal, 6-139
Textiles, knitting machine controls, 6-46
Theory of games, 10-148
Thermistors, 8-8; 9-69
Threading, 6-49
Timing, 9-49
Tool design, 9-43
Toothbrush manufacture, 6-50
Torque motor, 6-38
Training, 6-142; 7-128
Transducer, 6-52
Transfer machines, 8-66; 9-64, 74; 10-91; 11-37, 63
tooling, 11-15
Transient response, 8-110
dc motors, 6-82
Transistors, 7-128
manufacture, 7-11
Treer, K. R.
Automated Assembly, 10-50; 11-63
Tucker, D. P.
Reliability of Electronic Equipment, 8-30
Turning, 6-49; 10-83

U

Urano, A. S.
Automatic Controls in Pipe Production, 7-46

V

Vibration monitor 8-22
Vibratory feeding, 8-48
Voice frequency carriers, 9-66

W

Waldron, A. J.
Weighs the Advantages of Pneumatics for Process Control, 9-54
Walker, J. R.
Applying Magnetic Amplifiers, 11-71
Walter, L.
Fiberboard Manufacture, 6-68
Warehousing, 6-24; 8-37
Water works controls, 6-46
Wax molding, 6-58
Weather station, 6-15
Weighing, 11-44, 81
bulk, 8-44
Welding 11-9, 33, 67, 78
West, R. K.
Automatic Temperature Control, 10-78
Wire belt conveyor, 6-24, 32

Z

Zilius, R. B.
In-motion Weighing, 11-44